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Exploring Innovations in the Pedagogy of "Internet of Things Application Technology" Course for Graduate Students Oriented to New Agricultural Science

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Abstract: Within the realm of emerging agricultural sciences, the swift progression of the agricultural IoT (Internet of Things) sector is notable. It highlights the scarcity of applied IoT technical personnel. In order to meet the evolution of IoT technology and the urgent demand for professional and technical talents in smart agriculture, this paper discusses "the transformation and modernization of educational content and instructional strategies of "Internet of Things application technology". Based on the uniqueness of the course, the training goal of graduate students and the characteristics of our university, the teaching team has implemented a comprehensive optimization in teaching: Refreshed the curriculum and adopted cutting-edge pedagogical approaches, and improved the assessment system. Through these reforms, a new teaching model has been constructed, which integrates theoretical teaching and practical case analysis, echoes between basic knowledge points and the frontier dynamics of the field, and closely connects classroom learning and research projects. At the same time, combined with online and offline mixed teaching, further explored the teaching reform path of IoT application technology. These initiatives aim to ignite the academic enthusiasm of graduate students and enhance their practical capacity to utilize theoretical insights for tackling real-world issues.

Keywords: Teaching Reform; Graduate Education; New Teaching Mode; Diversified Assessment; New Agricultural Discipline

1. Introduction

Amidst the swift advancement of information technology, the IoT (Internet of Things) with its revolutionary influence, is recognized as the third major milestone in the information sector, following the advent of computers and the Internet. Through its deep integration with 5G, data analytics, machine learning, and associated advanced technologies in cutting-edge development, it has become a key force for economic development, social progress and scientific and technological innovation. Especially, Within the agricultural sector, the implementation of IoT technology extends beyond multiple dimensions such as facility agriculture, precision agriculture and smart agriculture, but also is pivotal in facilitating the transformation and advancement of these industries. The mutual promotion of AI (Artificial Intelligence) and the IoT technology provides rich data resources for the IoT, and AI can carry out deep mining of these data, which greatly improves the intelligence level of the IoT application. Therefore, it has become an urgent need of the society and the industry to cultivate high-level compound talents who master the information technology of the agricultural IoT.

In response to the extensive demand for IoT application technical talents within the realm of contemporary agriculture, our university has opened the "Internet of Things Application Technology" graduate course. This program is designed to equip graduate students with advanced theoretical knowledge and practical skills in the IoT domain, understand the latest development trends of IOT technology, and lay a solid foundation for future research and development and application related to IoT technology. The course content covers the IoT basic concepts, the IoT architecture, key

technologies and the latest progress of the IoT application in agriculture, including but not limited to ecological environment information sensing technology, soil moisture sensing technology, agricultural individual identification technology, agricultural remote sensing technology and other perceptual technologies, as well as agricultural wireless sensor network and other transmission technologies. There are also data processing technologies such as agricultural information forecasting and early warning, agricultural intelligent control, and agricultural intelligent decision-making. In terms of the application of agricultural IoT, the course content covers many application fields such as field planting, facility gardening, livestock and poultry intelligent breeding, and agricultural product traceability. It can be seen that the learning content of agricultural IoT technology is extensive and in-depth, and the learning difficulty cannot be underestimated.

However, the course in the early teaching practice, based on the IoT network architecture, mainly adopted the thematic teaching as the core model. Emphasis is placed on the transfer of knowledge and technology, with teacher-led classes. This is very suitable for students in the context of low knowledge penetration in the field of IoT technology. However, as the correlation between the course content and students' research interest and participation in scientific research projects gradually weakens, this teaching model is difficult to effectively stimulate students' active exploration spirit and innovative thinking. Especially in the process of the construction of new agricultural discipline, it is an obstacle to cultivate the innovation ability of excellent agricultural and forestry talents.

In view of the rich content and swift technological evolution within the curriculum of agricultural IoT technology, this paper takes cultivating students 'scientific research and practical ability as the core, and discusses the curriculum reform in depth. The goal of the reform is to realize the seamless integration of theoretical studies with practical research scenarios, the mutual complement of basic knowledge and the frontier of the field, and the effective connection of course learning and topic research, so as to explore and foster students' scientific acumen and innovative capabilities. In the design of the course curriculum, there is a close integration with the scientific research priorities of our university, and the new theory of the frontier of the discipline, the new demand of industrial application and the new technology of the field development are integrated into the teaching content. In terms of the integration of science and education, with the core concept of nourishing teaching with research findings, it is committed to building a teaching system of agricultural IoT technology supported by case teaching. This system aims to enhance students' comprehension of agricultural IoT technology and promote the development and innovation of related technologies. In terms of teaching methods, we build a diversified classroom environment through flipped classroom, teacher-student co-teaching, problem-oriented inquiry learning, goal-oriented research learning, and results reporting and display. In terms of assessment methods, the traditional single written examination has been changed to a thorough assessment of the learning experience, to facilitate a more holistic evaluation of student learning outcomes.

2. Challenges in Curriculum Teaching

In the teaching process of the postgraduate course "IoT Application Technology", there are mainly three prominent teaching challenges as follows.

2.1 Insufficient Integration of Curriculum Content and Ideological-Political Education

In previous teaching practices of "IoT application technology" course, the professional knowledge teaching is often disconnected from "ideological and political instruction, resulting in the deficiency of student spiritual cultivation and comprehensive quality. Engineering education demands that students not only acquire specialized knowledge but also possess commendable personal attributes and comprehensive ability. This requires the combination of professional courses teaching and ideological and political education, through the teaching activities of professional courses, imperceptibly affect students, and realize the far-reaching impact of education.

2.2 Complicated Course Content and Insufficient Experimental Resources

The IoT Application Technology course aims to give students an in-depth understanding of the core concepts, the IoT key technologies and application methods. The course is rich in content, covering a number of cutting-edge fields from automatic identification to sensor technology to radio frequency identification technology, spanning multiple disciplines such as computer science, agricultural engineering and automatic control. However, limited by the shortage of class hours and insufficient experimental facilities, students lack sufficient practical operation opportunities, which not only leads to the rupture between theory and practice, but also weakens the zeal of students for learning and the practical impact of instructional delivery.

2.3 Traditional Teaching Mode and Insufficient Utilization of Network Resources

Amidst the "Internet+" era, the conventional teaching paradigm has struggled to satisfy the demands of talent training. Despite the attention paid to blended teaching mode, online and offline teaching resources were not fully integrated in the course's instructional Prototype. The lack of cohesion and integration between online learning and classroom teaching leads to a single teaching content, a lack of personalized teaching and an effective course evaluation mechanism, which limits the improvement of teaching effect and the cultivation of students 'autonomous learning ability.

3. Related Teaching Reform Research Work

In the context of intensifying global competition, cultivating high-end innovative talents is crucial to enhancing national competitiveness and executing the strategy for national enhancement by talents, and is also the core of graduate education reform in the development of "dual first-class" initiatives. The course of IoT application technology integrates multi-disciplinary technical knowledge, with rapid expansion and continuous evolution of content, emerging new technologies and rapidly updated knowledge fields. The course not only focuses on the depth of theory, but also emphasizes the importance of engineering practice, and puts forward higher requirements for the comprehensive quality of students in order to cultivate innovative talents who can lead the future development of agriculture. To this end, the teachers of "IoT technology and application" have conducted a variety of instructional reform research work.

Rooted in the CDIO engineering education framework, Zhang et al. integrated the professional characteristics of forestry discipline and the latest exploring teaching reform in line with the developmental trajectory of IoT technology, aiming to improve teaching quality and students' hands-on skills [1]. Aiming to satisfy the social demand for IoT technical talents, Yan proposed market-oriented teaching reform measures for outdated course content and weak practice links, enhanced the instructional approach and refreshed the curriculum content, and strengthened the teaching practice [2]. Li et al. "put forward a course instruction design approach grounded in training principles of computational thinking and innovative ability for the courses of postgraduate computing theory [3]. Wang et al. studied the teaching reform and practice of the course under the SPOC mode in the "post-MOOC era", and discussed how to improve the educational outcomes and students' enthusiasm for learning [4]. Zhang et al. discussed the teaching reform of "IoT Technology and application" graduate courses amidst the AI age to adapt to the new requirements of technology development on education [5]. Han et al. explored and studied the enhancement of course practical teaching and emphasized the significance of hands-on instruction within the educational process [6]. Wu et al. studied "the transformation of IoT technology teaching methodologies utilizing the SPOC model and rain classroom, and proposed the rollout strategy for the blended learning approach of online and offline [7].Yao et al. discussed the teaching reform anchored in a project-based instructional approach, which aims to deepen students' comprehension of theoretical concepts, bolster their practical skills, as well as and teamwork ability by combining practical projects with course content, "to effectively foster students' capacity for innovative application and meet the talent demand within the IoT sector [8]. Based on the concept of "four integration", Cao explored the pedagogical innovation and practical implementation of foundational courses of IoT technology, aiming to enhance the

instructional outcomes and the student learning journey [9]. Duan et al. discussed the revamp of the IoT technology curriculum in response to contemporary developments, emphasized the importance of ideological and political ideas in the course, and put forward the strategy of incorporating ideological and political elements into the curriculum of specialized courses to enhance the overall quality and ethical development of students [10].

The above teaching reform research covers many aspects regarding the pedagogical transformation of the IoT application technology curriculum, including teaching concept, curricular content, instructional approach, and hands-on instruction as well as teaching mode, etc., providing certain teaching and practical guidance for the pedagogical innovation of the IoT Application Technology course.

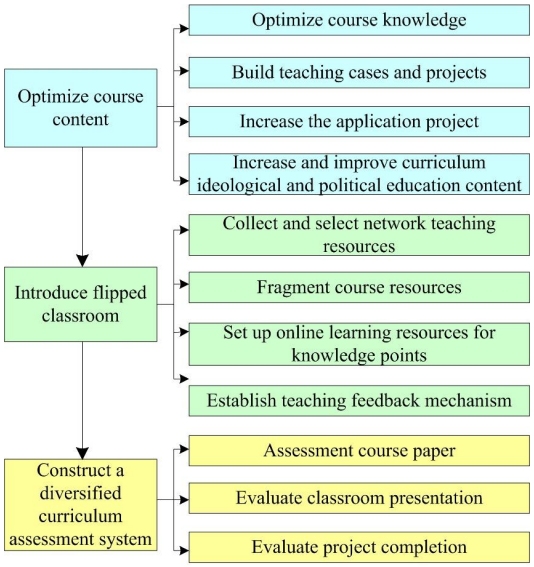

Figure 1. Teaching Reform Roadmap

4. Teaching Reform Scheme

The course of "IoT Application Technology" offered by our university for graduate students is 32 hours, all of which are theoretical hours. It is designed to equip students with a solid grasp of IoT foundational knowledge. Also it makes students deeply understand the core functions and key technologies of the perception control layer, data interaction layer, information fusion layer and application service layer. The course content covers the basic principles, latest achievements, the prospective developmental directions of typical systems, as well as technologies of agricultural IoT, establishing a robust basis for students' in-depth applications and research within the realms of agriculture and animal husbandry. To attain this educational objective, in view of the challenges encountered in the teaching of "IoT application technology", This manuscript proposes transformative and innovative strategies concerning the curriculum content, instructional approaches, and assessment frameworks, to enhance the instructional outcomes as well as the student learning journey.

The idea of teaching reform is shown in Figure 1.

4.1 Stay Abreast of the Latest Professional Development Trends and Optimize Course Content

4.1.1 Optimize expertise content

In the process of optimizing the teaching content of the IoT application technology course, the scientific research characteristics of our university as an agricultural university are fully considered, and the course content is comprehensively adjusted in combination with the latest development trends of the IoT, 5G, data analytics, AI and associated technological advancements. "Aligning with the evolving demands of the agricultural IoT technology sector, while improving the systematic teaching content, we actively explore the optimal integration of scientific research, practice and theoretical teaching content. With an application orientation, the theoretical knowledge is refined and the learning experience of graduate students is deepened in the project practice.

The course content is divided into two parts: theory and practice. Through in-depth research and the use of online course resources, appropriate teaching content is selected, and detailed teaching syllabus and teaching plan are formulated according to the characteristics of postgraduate courses. In order to strengthen practical application teaching, the teaching team added design and research experiment content, as students' homework, to promote students' innovative experiment ability. In addition, students are given greater freedom to better ignite their passion for proactive learning and inquisitive exploration.

On the premise of enhancing the systematic

and advanced nature of the teaching content, it actively explores the optimal combination of scientific research, practice and theoretical teaching content. For example, through the project-driven teaching model, students are involved in practical projects to improve their practical skills and innovative capabilities. In order to strengthen practical application teaching, design and research experiments have been added, such as the practical operation of the application system development of the IoT system, enabling students to acquire and proficiently understand IoT technology in practice.

4.1.2 Optimize course ideological and political elements

According to the trend of professional development, the following measures have been taken to optimize the course's ideological and political elements.

Through the course content, students will have a deep understanding of the superiority of the public policy framework, especially the importance of the agricultural IoT industry for national construction. Through case analysis, such as the construction process of the Beidou positioning system and its strategic significance, students' national consciousness and pride are strengthened.

In the course, the development status of China's mobile Internet, the discussion of Huawei sanctions, and the issue of privacy security in the era of big data are integrated to guide students to establish correct fundamental principles of the social and political system and enhance their sense of social responsibility.

The IoT technology utilization in the field of agriculture will be discussed in the course, such as smart agriculture, lake wetland environmental monitoring, etc., so that students can understand how IoT technology can help the modernization of the country.

Throughout the instructional process, students are motivated to take the initiative to learn and explore research, such as the case of helping epidemic prevention and control through IoT technology, to ignite students' passion for learning and drive for innovation. Through these measures, ideological and political education is successfully woven into the "IoT application technology" course, and high-quality IoT technology talents are trained for the country.

4.2 Enrich the Teaching Model

In order to promote active participation and in-depth understanding of students, the traditional teacher-centered teaching model is transformed into a "flipped classroom". In this model, students are no longer passive recipients of knowledge, but active participants. The specific reform measures are as follows.

Each student is required to independently learn typical IoT applications through Internet resources before class, including but not limited to cutting-edge technologies and application cases in the fields of smart agriculture, smart farming, and agricultural digitalization. Students are required to choose a IoT-related research direction that they are personally interested in, conduct in-depth exploration, and prepare relevant PPT courseware.

In class, each graduate student explains his or her research, presents his or her research results, and reports back to the teacher and classmates. This process not only requires students to demonstrate knowledge, also encourage them to share their personal opinions and thinking.

During the presentation and after the presentation, other students can ask questions or suggestions at any time, and interact with the presenter, so as to stimulate classroom discussion and promote in-depth understanding and application of knowledge. Teachers provide instant comments on student presentations and presentations, provide professional feedback, and point out directions for improvement. This not only helps students to recognize their own shortcomings, but also recognizes and encourages their learning achievements.

Through this interactive learning, students' participation in the classroom has been significantly improved and the classroom atmosphere has become more active, thus deepening students 'knowledge and understanding of the specific application of IoT technology. Teachers' comments and interaction with classmates provide students with valuable learning opportunities,

contribute to their growth and progress, and develop critical thinking and problem solving skills.

4.3 Implement Project-Based Instructional Approach

Drawing from recent scientific advancements in agricultural IoT research, this course focuses on the core content of agricultural IoT application technology, including but not limited to the latest sensor data acquisition technology, wireless sensor network construction and data transmission technology, intelligent data processing technology, and intelligent control technology of facility cultivation (aquaculture) and other key knowledge points. Through the construction of teaching case projects, the teaching team deeply refined the teaching cases of data acquisition, transmission and control technology of the IoT, adopted the methodology centered around project implementation, incorporating scientific research findings to teaching practice, aiming to cultivate students' capabilities in engineering application and autonomous innovation.

4.4 Establish a Multi-dimensional Curriculum Evaluation System

To assess the overall quality of students, this course adopts a variety of evaluation methods and comprehensive examination content. Specifically, it integrates four assessment methods: mid-term examination of research projects, research papers, design and implementation of project functions, and presentation in class. Students' study and research is check and supervised through the mid-term examination report. Through the research project paper, the aim is to test the students' grasp of the theoretical knowledge of the curriculum and the latest technology, and to improve their academic writing. The practical part of the program focuses on students' ability to apply theoretical knowledge to practical operations, while developing their practical skills and innovative thinking. Classroom presentation can not only reflect students' autonomous learning ability in the application field of IoT technology, and also enhance their logical reasoning and verbal communication abilities. Based on the comprehensive application of these four evaluation methods, students' learning outcomes inside and outside the classroom can be comprehensively and systematically evaluated, so as to effectively evaluate their comprehensive ability.

5. Conclusion

To sum up, in order to meet the demand for agricultural IoT technical talents under the new agricultural discipline background, the IoT application technology teaching reform plan proposed in this paper. Through revamping the curriculum content, pioneering innovative pedagogical approaches and perfecting the examination system, a teaching mode combining theory and practice is constructed. This reform aims to stimulate graduate students' enthusiasm for learning "thereby enhancing their capacity to utilize knowledge for addressing real-world issues, contributing to the development of smart agriculture. We expect that these measures can provide useful references for the training of IoT technical talents, and further refine and elevate in subsequent educational endeavors.

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