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Construction and Practice of Innovative Talent Cultivation System in Automation-Related Majors

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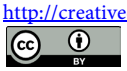

Abstract

In the New Engineering Education background, there are problems in the training of automation-related majors innovative talents. Based on the practice-driven innovation concept of automation engineering leading education and the requirements of transformation and development, the automation specialty of Inner Mongolia University is combined with the requirements of new engineering talent training, from the revision of talent training plan, curriculum system and practice system construction. An open and collaborative intelligent manufacturing innovation talent training system and innovation and entrepreneurship education run through the whole process of talent training, innovation and entrepreneurship have achieved remarkable results, and professional upgrading and transformation have achieved certain results. It satisfies the requirements of knowledge, ability and literacy cultivation. The experience and practices in the practice process can be used as a reference for similar majors.

Keywords

Automation-Related Majors, Innovative Talent Cultivation, Training System

1. Introduction

1.1. Statement of the Problem

In the past decade, the curriculum system of automation-related majors has been continuously improved and innovated, and incorporated some advanced educational research results. However, most courses are structured according to disciplines, focusing mainly on theoretical unity and consensus within the discipline. There is a deficiency in cross-disciplinary connections among various

courses and related peripheral disciplines. Furthermore, the practical teaching components are noticeably insufficient, leading to limited opportunities for students to engage in practical activities and develop problem-solving abilities in real-world scenarios. Meanwhile, the course design for automation-related majors tends to be generic, with insufficient consideration given to the development trends and needs of the region or even the society. It has failed to establish the professional characteristics of this major in the context of the new engineering disciplines. Ren et al. conducted research on the cultivation of student innovation ability in Lanzhou Institute of Technology, focusing on the construction of curriculum system and innovation and entrepreneurship system (Ren et al., 2023). Man et al. conducted research and practice on talent training programs for automation majors under the OBE concept at Wuyi University (Man et al., 2020). Xiong et al. conducted teaching and research work at Jiangnan University and constructed a student training quality evaluation system to ensure the training quality of automation major students (Xiong et al., 2022).

1.2. Necessity and Feasibility of the Research and Reform

The Party and the state have attached great importance to the issue of cultivating innovative talents for a long time, repeatedly putting forward strategic goals and policy guidelines regarding the cultivation of innovative talents. The strategies of revitalizing the country through science and education, strengthening the country through talents, and driving development through innovation have been highly valued by relevant departments and gradually implemented. However, when implemented in specific educational practices, there is still room for further improvement and enhancement in areas such as improving the performance of cultivating innovative talents, categorizing the cultivation of outstanding innovative talents, constructing a curriculum system for cultivating innovative talents, and establishing mechanisms for collaborative cultivation of innovative talents (Li et al., 2023).

1.3. Core Issues in the Research and Reform

1.3.1. Students Exhibit a Relative Weakness in Their Professional Foundations, as Well as Inadequate Abilities in Logical Thinking and Problem Analysis

In the context of the new engineering disciplines, in which knowledge is rapidly updated, higher demands are placed on the professional foundations of automation-related talents. Students with solid professional foundations are more capable of learning new knowledge and adapting effectively, with robust development potential. Effective approaches are needed to strengthen these professional foundations and enhance students' logical thinking and problem analysis abilities.

1.3.2. The Practical Teaching System Is Not Sufficiently Developed, Resulting in Students Having Comparatively Weaker Practical Skills and Independent Thinking Abilities

Traditional practical teaching components are scattered, the content is relatively

outdated, and there is a disconnect between theoretical and practical teaching. The integration between the primary and secondary classrooms is not close, and there is a lack of effective mechanisms to measure and guide students' practical abilities. Consequently, students are deficient in terms of possessing strong practical skills required to solve intricate engineering problems.

1.3.3. The Positioning of Entrepreneurial and Innovative Education Is Not Clear Enough, Leading to a Relatively Inadequate Students' Innovation Awareness and Practical Innovation Abilities

Traditional entrepreneurship and innovation education lacks organic integration with professional education, and is often simply understood as organizing entrepreneurial and innovative activities or participating in related competitions. The positioning, platform, and mechanism of entrepreneurship and innovation education are not clear, well-established, or perfected, leading to students' inadequate innovation awareness and limited practical innovation capabilities.

2. Research and Reform Practices

2.1. Research Methods and Process

Since 2010, the project team has conducted six years of research and exploration, as well as six years of practical verification, on the cultivation system for innovative talents in automation, relying on projects such as the autonomous regional experimental teaching demonstration center. They proposed a talent cultivation philosophy of "student-centered, foundation-based, practice-oriented, and innovation-driven", as well as an entrepreneurial and innovative education philosophy of "strengthening practice while reducing indoctrination, emphasizing flexibility over rigidity, and enhancing incubation and cultivation". They constructed a "curriculum-led, platform-supported, and collaborative-driven" training model for innovative talents in automation, which contains three levels of progressive ability enhancement:

Curriculum guidance, emphasizing the strengthening of basic knowledge. Through the "four-round drive" of "strengthening the basics, broadening the scope, improving quality, and increasing efficiency," the foundation is consolidated, and students' logical thinking and problem analysis capabilities are enhanced.

Platform support, emphasizing strong practical experience. By making practical teaching the core and using practical teaching platforms and practical innovation platforms as the two wings in the "one body, two wings" approach, practical skills are strengthened, and students' ability to address complex engineering problems through practical work is enhanced (Wang et al., 2022b).

Collaborative driven, emphasizing strong innovation. Through the "trinity" of "collaboration between science and education, integration of industry and education, and cooperation between schools and enterprises," innovation is promoted. This is achieved by implementing a collaborative approach that combines classroom learning with laboratory research, school-based learning with research, and enterprise engagement in research, production, and application. A

new model for cultivating innovative talents is constructed, which integrates immersion, collaboration, and diversity, aiming to enhance students' innovative thinking and practical skills.

2.2. Educational Teaching Plan

2.2.1. Curriculum Guidance, "Four-Round Drive," Consolidating the Professional Foundation

The 2023 Talent Training Program implements the teaching reform approach of "strengthening the foundation, enhancing growth and development education, strengthening general education, strengthening innovation and entrepreneurship education, and strengthening interdisciplinary education." Strengthening the foundation: The curriculum system has been optimized, with the addition of Discrete Mathematics (32 class hours) and increased emphasis on foundational courses such as Mathematics, Physics, and Electronic Technology, accounting for 32.4% of the total credits required for graduation. Broadening horizons: Specialized courses have been expanded to include interdisciplinary subjects such as Artificial Intelligence, Machine Vision, and Image Processing, as well as special lectures on advanced robotics technology, aimed at broadening students' knowledge base. Enhancing quality: Research training and comprehensive practical teaching components have been introduced, focusing on both the primary classroom and extracurricular activities, to improve the quality of teaching. Increasing efficiency: Modern information technology tools are utilized to enhance classroom teaching efficiency. Software platforms such as CAD, MATLAB, Multisim, Proteus, Keil, and SystemView are introduced in the course teaching (Liu & Liu, 2023).

2.2.2. Platform Support, "One Body, Two Wings," Strengthening Practical Teaching

The implementation of the "student-centered, learning-teaching-innovation practice experience" three-element support innovation talent cultivation model has been carried out. Supported by basic training and professional practice, it breaks down the barriers of traditional courses, integrates and optimizes practical teaching contents, upgrades and transforms practical teaching courses into engineering design projects. It incorporates program design, production debugging, analysis improvement, teamwork, innovative spirit, autonomous learning, etc., into course design, scientific and technological competitions, and innovation projects, aiming to cultivate design thinking abilities, knowledge integration and application abilities, enhance engineering practice abilities, and foster innovation and entrepreneurship capabilities.

Integration: Practical teaching is the main focus, integrating theoretical knowledge into projects, allowing students to apply what they have learned to practice more quickly, thereby deepening their understanding of new knowledge.

Dual wings: Two practical platforms are established. One is the undergraduate laboratory, which serves as the practical teaching platform. The other is the Inner Mongolia University "House of Innovation," which serves as the plat-

form for student research training and innovation practice. This platform is jointly built by the university and colleges to support student research training and innovation practice.

2.2.3. Collaborative Drive, "Trinity," Promoting Innovative Education

Promoting the school-enterprise cooperation model and building a collaborative education platform. The implementation of the "Grassland Eagle" innovative talent cultivation program includes participation in the university-level electronic circuit design competition, application for student innovation and entrepreneurship training program projects, and participation in extracurricular academic and technological competitions. This achieves the goal of "collaborative education, school-enterprise cooperation, complementary advantages, co-construction, and sharing for win-win outcomes" and forms a virtuous cycle of "teaching-research-industry-application-teaching" in collaborative education.

Collaboration between science and education: Introduction of disciplinary strengths and establishment of mechanisms for collaborative education between science and education. Effective transformation of scientific research achievements into teaching content, reasonable integration of research methods in the teaching process, expansion of research directions, strengthening of innovative consciousness, and cultivation of innovative spirit (Wang et al., 2022a).

Integration of industry and education: Integration of industry and education by formulating project-based teaching and training standards. Relying on in-depth collaboration between industry and education, conducting thorough enterprise investigations, and carrying out school-enterprise cooperation.

School-enterprise cooperation: Interaction between schools and enterprises, exploring the "teaching-design" model. Through the approach of "learning by doing" and "doing while learning," students participate in enterprise research and development projects and engineering examples to cultivate comprehensive qualities and engineering capabilities of future engineers.

2.3. Implementation Measures

2.3.1. Implementing an Undergraduate Mentorship System to Prioritize Student Development

In 2015, the undergraduate tutorial system began to be implemented in automation-related majors. The tutorial system is divided into two stages: the first stage focuses on guidance during the freshman year, while the second stage focuses on guiding research during the sophomore, junior, and senior years, with the aim of guiding students to participate in scientific research training and consciously cultivating their innovation consciousness, practical abilities, and comprehensive qualities.

Establishing the tutorial system is an important measure for automation-related majors to establish a "student-centered" educational philosophy, deepen educational reforms, and improve the quality of undergraduate talent cultivation. It is also an effective way to strengthen communication between teachers

and students, as well as guide and motivate students to innovate.

2.3.2. Implementing the "Grassland Eagle" Innovative Talent Training Plan, Focusing on Student Capability Development

To comprehensively implement the spirit of the "National Reform and Development Plan Outline (2010-2020)" and in accordance with the requirements of Inner Mongolia University's "Double First-Class" construction work, great efforts have been made to cultivate students' innovative spirit and abilities, effectively improve the students' own qualities and competitiveness in employment, and enhance the school's level of education and the quality of talent cultivation. In 2015, the automation-related majors formulated the "Grassland Eagle" innovative talent cultivation program.

The program is implemented in three stages: all students participate in the college-organized university-level electronic circuit design competition; organizing the application for student innovation and entrepreneurship training program projects; organizing participation in extracurricular academic and technological competitions for students (Ren et al., 2023).

2.3.3. Implementing an Integrated, Collaborative, and Diversified Innovative Talent Training Model

Based on the "Undergraduate Program Directory of Regular Higher Education Institutions," "National Standards for Teaching Quality of Majors," and "General Standards for Engineering Education Accreditation in China," and in accordance with the guidance document "Guidelines for the Revision of Undergraduate Talent Cultivation Programs at Inner Mongolia University," the talent cultivation program has been revised. The new version of the talent cultivation program has the following three characteristics:

1) All three major categories of courses in the college are integrated, implementing unified teaching and allowing students to freely choose courses regardless of their majors. In the lower grades, classes are taught by category, focusing on general education and basic professional education. In the higher grades, there is a wide range of professional education, while emphasizing the integration and cross-disciplinary nature of subjects.

2) Elective courses in each major are divided into two course clusters based on different directions, allowing students to choose different directions of study within their chosen major based on their interests and strengths.

3) The emphasis on practical teaching has been increased, with practical credits accounting for more than 30% of the total credits. Additionally, the program has increased the emphasis on extracurricular activities, including student competitions, research training, artistic activities, sports competitions, and public welfare activities.

2.4. Theoretical Achievements

It has put forward the talent cultivation concept of "putting education first, with a foundation in basics, practice as the basis, and innovation as the soul," as well

as the dual-creation educational concept of "strong practice, weak indoctrination; strong flexibility, weak rigidity; and strong incubation with increased nurturing" combined with the profession. This has constructed an automation-oriented innovative talent cultivation model based on "curriculum guidance, platform support, and collaborative driving."

It has proposed a new model for cultivating innovative talents with capabilities at its core, comprising the "integration of the two wings," "three-in-one," and "four-round drive."

3. Conclusion

3.1. Steady Improvement in the Quality of Graduate Education and Continuous Enhancement of Innovation and Entrepreneurship Capabilities

The average employment rate for undergraduate students is above 85%, and the enrollment rate for graduate studies is above 20%. The quality of employment and further education has steadily increased. A total of 159 projects have been approved for the "College Students' Innovation and Entrepreneurship Training Program," with over 65% of students participating in the program. Students who have participated in extracurricular academic competitions have won three second prizes and four third prizes at the international level, as well as one grand prize, eight first prizes, 18 second prizes, 20 third prizes, and six outstanding awards at the national level. At the provincial and ministerial levels, six first prizes, 16 second prizes, and 48 third prizes were awarded. The results of a national-level college students' innovation and entrepreneurship training program, led by two students, were selected as excellent exhibits at the college students' innovation and entrepreneurship annual conference hosted by the Ministry of Education, demonstrating that students' innovation and entrepreneurship abilities are constantly improving.

The achievements have benefited a wide range of people, and the quality of talent cultivation has been high. Over the past decade, more than 2000 automation-oriented talents have been cultivated, and graduates have been praised by employers and institutions of higher education for further studies. For example, they have won the 2022 China Power Industry Management Innovation Grand Prize, the second prize of the China Petroleum Engineering Construction Association, the PLA's "Four Good" Outstanding Officer Award, the Outstanding Individual Award at DJI, and a 2013 undergraduate student, Sun Guibin, was admitted to the direct doctorate program at Beijing University of Aeronautics and Astronautics and stayed on as a teacher after graduation.

3.2. Distinctive Features in the Practical System, Cross-Platform Integration, and Wide-Ranging Student Benefits

A total of 42 experimental courses and 15 research-oriented practical courses have been offered, with over 500 experimental projects, and innovative and

comprehensive design projects accounting for over 50%. The wide coverage of experimental content serves all six majors in the college, benefiting over 1000 students annually. The college has jointly established a "Science and Education Innovation Base" with ALDEBARAN Robotics from France, Beijing Ironman Technology Co., Ltd., and Shenzhen Yuejiang Technology Co., Ltd. to provide innovative education and practical platforms for students.

3.3. The Establishment of a Group of First-Class Quality Teaching Resources, Optimizing the Student Growth Environment

The project "Exploration and Practice of Transformation and Upgrading of Automation Major under the Background of New Engineering Education" has been approved as the second batch of New Engineering Research and Practice Projects by the Ministry of Education. All three undergraduate majors have been selected as first-class undergraduate majors in the autonomous region, and two teachers have won the "New Talent Award" for higher education in the autonomous region. Five courses have been approved as first-class undergraduate courses in the autonomous region, and one course has been approved as an online open course in the autonomous region. Four textbooks in the Engineering Mathematics series have been published, winning the second prize of the Teaching Achievement Award in the autonomous region. "Sensor and Detection Technology" has been selected as a national "Twelfth Five-Year Plan" higher education planning textbook and has been adopted by more than 10 universities. "Modern Control Theory" (textbook) has won the first prize of the "Eleventh Five-Year Plan" excellent textbook award. The Engineering Mathematics series textbooks have been selected as teaching materials by more than 20 universities, including Sichuan University, North University of China, Ocean University of China, Inner Mongolia University, and Hebei University. As of 2021, the cumulative sales of books have exceeded tens of thousands of copies, which has played a radiation and demonstration role in the reform of engineering mathematics course teaching.

Under the background of new engineering, colleges and universities should innovate teaching concepts, expand diversified training paths, strengthen school-enterprise cooperation, and form a joint force of talent training, so as to improve the quality of talent training.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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