

Research on the Construction of Specialized and Innovative Integration Courses Based on "Hydraulic and Pneumatic Technology"

Xiaoli Wang

Changchun Technical University of Automobile, Changchun, Jilin 130000

Abstract: Based on the concept of innovation and entrepreneurship education, this paper discusses the construction method of the specialized-innovation integration course of "Hydraulic and Pneumatic Technology", analyzes the existing pain points in the current course teaching, and proposes the construction ideas of the specialized-innovation integration course. It elaborates from five aspects: reconstruction of course objectives, construction of course content, development of teaching resources, construction of teaching models, and diversification of teaching evaluations. The research on the specialized-innovation integration of professional courses is conducive to improving the quality of talent cultivation, promoting the reform of vocational education, and promoting the integration of industry and education as well as school-enterprise cooperation, achieving a virtuous cycle of "enterprise demand - course training - talent output".

Keywords: hydraulic and pneumatic technology; integration of specialization and innovation; course construction

DOI:10.12417/3029-2328.25.10.028

1. Research Background

The Outline of the Plan for Building an Education Powerhouse (2024-2035) points out that the country's demand for high-quality technical and skilled talents is increasingly urgent, and it requires vocational education to cultivate compound talents with innovative spirit and practical ability ^[1]. Recently, The General Office of the State Council issued the "Guiding Opinions on Further Supporting College Students' Innovation and Entrepreneurship", proposing to deepen the reform of innovation and entrepreneurship education in colleges and universities, incorporate innovation and entrepreneurship education throughout the entire process of talent cultivation, and establish a new talent cultivation model oriented towards innovation and entrepreneurship ^[2]. This means that innovation and entrepreneurship should be effectively integrated into professional course teaching. In the cultivation of students, it should not be limited to imparting professional knowledge, but should further expand students' career development capabilities and adaptability to achieve a good integration of professional knowledge and innovation and entrepreneurship.

At present, some scholars have made explorations on integrating innovation and entrepreneurship education into the construction of professional courses. Zhu Muzhi, in line with the requirements for cultivating innovative and practical abilities, carried out the construction of course content and practical project teaching for the hydraulic servo and Proportional Control system course ^[3]. Zhao Jian et al. proposed a practical path for integrating innovation and entrepreneurship education with professional education in local undergraduate colleges, which takes innovation as the integration orientation, courses as the integration carrier, win-win as the integration goal, and linkage as the integration foundation ^[4]. Li Huadong et al. proposed to optimize the cultivation model of students' innovation and entrepreneurship capabilities in university departments by promoting the integration of "all-round education" and "Internet +" into innovation and entrepreneurship education, and building a "six-in-one" governance system for innovation and entrepreneurship education in departments ^[5].

Hydraulic and pneumatic technology, as an important branch of mechanical engineering, is widely applied in modern industrial production. However, the traditional teaching process often focuses on imparting technical principles and operations, lacking the cultivation of students' innovative thinking and entrepreneurial abilities. At present, there are the following pain points in the teaching of hydraulic and pneumatic technology

- (1) The teaching content is overly theoretical and disconnected from engineering practice.
- (2) The update of experimental equipment lags behind, making it difficult to keep up with the cutting-edge of

technology.

- (3) The teaching methods are monotonous and lack training in innovative thinking.
- (4) The evaluation system emphasizes knowledge over ability.
- (5) Insufficient integration of innovation and entrepreneurship elements.

2. Construction of the Specialized and Innovative Integrated Course "Hydraulic and Pneumatic Technology"

The construction of specialized and innovative integration courses aims to:

- (1) Break the phenomenon of professional education and innovation and entrepreneurship education being disconnected from each other.
- (2) Cultivate compound talents who are proficient in professional technology and possess innovative capabilities.
- (3) Enhance students' ability to solve practical engineering problems.

In the course construction, it is carried out in a five-step manner: industrial demand research and analysis, course teaching objective design, modular development of course content, teaching implementation design, and optimization of the evaluation system, as shown in Figure 1. Through industry research and professional ability analysis, clarify the industrial demands. Based on industrial demands, the course objectives are formulated from the perspectives of knowledge, ability and quality, precisely aligning with the content of typical job positions in hydraulics and pneumatics, providing a guiding direction for the reconstruction of course teaching content. Based on the course objectives, rationally construct the course content, design teaching projects based on real projects, and establish a project library. Establish an integrated curriculum that covers basic knowledge, project entities, innovative consciousness and practical operation. Design teaching activities in accordance with students' demands for "learning" and "applying", and rationally design teaching implementation plans to ensure the improvement of teaching quality and effectiveness. Set up diversified evaluation methods to stimulate students' enthusiasm for learning.

2.1 Reconstruction of Course Objectives

The course "Hydraulic and Pneumatic Technology" serves as a fundamental course for equipment manufacturing majors, aiming to cultivate high-quality technical and skilled talents capable of engaging in the production, installation, commissioning, maintenance, and technological transformation of mechatronic equipment [6]. In order to cultivate students' creative ability, stimulate their entrepreneurial spirit, and enhance their comprehensive quality, so that they can better adapt to the complex and ever-changing social environment and better meet market demands, through the cultivation of science and technology innovation projects, competition projects, and school-enterprise cooperation platforms, a "professional + innovation and entrepreneurship" curriculum is constructed. Based on industrial demands, the teaching objectives of the courses are optimized and reconstructed, and a three-dimensional objective system of "knowledge - ability - quality" is constructed. Master the basic principles and cutting-edge developments of hydraulic and pneumatic technologies in the knowledge dimension. The capability dimension cultivates the abilities of system design, installation and commissioning, problem-solving, and innovation and entrepreneurship. The quality dimension forms engineering ethics, safe operation, economy and environmental protection, and teamwork spirit.

2.2 Course Content Construction

Through research, distill and analyze the development trends of hydraulic and pneumatic technologies and the talent demands of the industry, and clarify the course objectives. Integrate elements of innovation and entrepreneurship education into the curriculum content and design a modular curriculum system. Set up practical links for innovation and entrepreneurship, strengthen the cultivation of students' practical abilities, and cultivate

compound talents with innovative spirit and practical ability. Starting from the actual operational needs of enterprises, and in combination with college students' innovation and entrepreneurship, academic and technological and other competition projects, an integrated curriculum that combines "basic theoretical knowledge + actual project entities" with students' practical operation, innovative thinking and entrepreneurial ability cultivation is established.

Based on the educational positioning, in combination with the professional talent cultivation goals and industry demands, the teaching module content is reorganized. According to the knowledge, ability and quality requirements to be achieved in the course objectives, the teaching content is divided into five unit modules: basic theory, structure and maintenance of hydraulic and pneumatic components, circuit design, fault diagnosis and system integration. Establish knowledge points in layers, progress step by step, plan the teaching, and highlight key and difficult points. The unit modules after content reconstruction are shown in Table 1.

Table 1 Modular Development of Course Content

Module	Content of industrial connection	Teaching carrier
1.Basic Theory	Industry application scenarios (such as hydraulic systems of machine tools and excavators)	Real case videos of enterprises
2 Component structure and maintenance	Disassembly and assembly of brand components (Rexroth, Huade, SMC, etc.)	Scrapped components donated by enterprises
3 Circuit design	Demand for pneumatic circuits in automated production lines	Festo Simulation Training Platform
4 Fault diagnosis	Enterprise common Fault database (such as cylinder crawling, unstable pressure, leakage, excessively high oil temperature, etc.)	Virtual maintenance AR software
5 System integration	Control with PLC and sensor systems	Case studies of school-enterprise cooperation projects

2.3 Teaching Resource Development

In accordance with the requirements of the course objectives, and in combination with the technical standards and implementation processes of typical enterprise projects, design and develop teaching materials, loose-leaf work orders, etc. that incorporate innovation and entrepreneurship cases. Collect and organize innovation and entrepreneurship cases in the field of hydraulic and pneumatic technology, and establish a case library, such as in the loop design module. The adopted cases include the door lock circuit of the paint drying furnace, the control circuit of the hydraulic crane, the hydraulic speed control circuit of the heat treatment tempering furnace, the multi-cylinder sequential action circuit of the hydraulic bending device, etc. The course incorporates cutting-edge technologies such as the hydraulic system of wind turbines and intelligent unmanned hydraulic engineering machinery, etc ^[7]. Upgrade the practical training conditions, drive with specific projects, carefully design, give full play to the subjective initiative of students, and achieve the connection between project tasks and the structure system of course content.

2.4 Construction of Teaching Mode

The course adopts a five-in-one teaching model that combines "teaching - learning - research - creation - evaluation". Under the innovation and entrepreneurship platform promoted by teachers and the school, practical project teaching is carried out, turning the works in the projects into products, guiding students to understand market demands, clarify product positioning, and experience the charm of the course. Realize the integration of professional technology and business, instill the awareness and concept of entrepreneurship in students' hearts, and cultivate their spirit of innovation and entrepreneurship.

For example, for the direction control circuit part in the basic hydraulic circuit, the carrier is selected as the hydraulic crane reversing and self-locking circuit. The teacher explained the principles and functions of the circuit,

and at the same time incorporated engineering application cases based on scientific research projects. Through forms such as "asking questions", "presenting cases", and "short videos", the teacher promoted in-depth interaction with students and enhanced the interest of the class. Subsequently, the project-driven teaching method was adopted. On the basis of understanding theoretical knowledge, students released the design of the reversing locking circuit for the paint drying furnace door. The task implementation was carried out with students as the main body, and teachers guided students to complete the entire process from project design to implementation. The specific task implementation process is shown in Table 2. Students formulate the usage plan for hydraulic components, simulate the design to build the circuit, and conduct verification by connecting the experimental platform. By applying the case teaching method and analyzing successful cases, students' innovative thinking can be inspired.

Table 2 Task implementation process table

Implementation steps	Step specification	The achieved goal
Task Introduction	1. Understand the key points of the task 2. Sort out key knowledge points	Knowledge objective: Relevant theoretical knowledge Ability objective: The ability to independently analyze and solve problems Quality goals: Pioneering awareness, innovative awareness
Task Preparation	1. List the names and symbols of the equipment required for the task 2. Review the equipment and preparatory work required for the task 3. Understand the standard operation of hydraulic and pneumatic components	Ability goals: The ability to consult and analyze, as well as the ability to self-learn Quality goals: Rigorous and responsible
Task Implementation	1. Record the experimental data and corresponding parameters 2. Master the principles and conduct thorough analysis 3. Standardize operations and complete tasks	Knowledge objective: Relevant theoretical knowledge Ability objective: Practical ability Quality goals: Enjoy hands-on activities, have an exploratory spirit, and pay attention to details
Task Termination	1. Complete the filling of the self-inspection form 2. Achievement Presentation and Optimization	Knowledge objective: Relevant theoretical knowledge Ability objective: Organization and summary of content Quality goals: Stimulate innovative potential and love for the major

2.5 Diversification of Teaching Evaluation

Establish diversified evaluation methods and incorporate students' participation in innovation and entrepreneurship activities and completion of innovation and entrepreneurship projects into the evaluation scope. Emphasize process evaluation and pay attention to students' progress and growth during the learning process. Introduce enterprise evaluation and take the assessment of students' innovation and entrepreneurship capabilities by enterprises as an important reference. Based on the restructured curriculum objectives, an evaluation model is constructed from three dimensions: knowledge, ability, and quality. The evaluation of students is expanded from the

original aspects such as professional learning, classroom performance, and activity communication to aspects such as application and innovation ability, execution and organization ability, teamwork and coordination ability, etc. The evaluation forms adopt various methods such as self-assessment by students, peer assessment among students, and comments from teachers. In addition, pay attention to the timeliness of evaluation, allowing students to promptly understand their own learning situation and urging them to summarize and reflect on the learning process. Establish a feedback mechanism to optimize the teaching of specialized and innovative integration courses.

3.Conclusion

Through the curriculum reform of "Hydraulic and Pneumatic Technology" guided by the concept of innovation and entrepreneurship education, the problems faced by the construction of vocational undergraduate courses, such as the conceptual predicament, organizational predicament, resource predicament, teacher predicament, and integration predicament, have been solved. The course emphasizes the combination of theory and practice, virtual simulation and practice, and project case analysis and innovation training. A modular and hierarchical integrated professional and innovative curriculum has been formed. The construction of specialized and innovative integration courses is an important measure to meet the requirements of new engineering education. By reconstructing the curriculum system, innovating teaching methods and building practical platforms, it can effectively cultivate engineering and technical talents with innovative spirit and entrepreneurial ability, thereby better serving regional economic development and industrial upgrading.

Acknowledgement

This work was supported by:

Project of the Innovation and Entrepreneurship Education Teaching Guidance Committee for Vocational Colleges in Jilin Province: Research on the Integration of Professional Education and Innovation in the "Hydraulics and Pneumatics" Course Based on the Concept of Innovation and Entrepreneurship Education(CXCYZHW2025046).

References:

- [1] Wang Youmei,Huang Fangqin,Chen Kaizhe,et al.The"Outline for Building an Education Powerhouse(2024-2035)"promotes High-Quality Development of industry-Education Integration in Vocational education[J].China Education Informatization,2020,31(06):12-20.
- [2] Yang Feng,Yang Xinjuan,Wang Yanhua.The Educational Concept and Practice of Integrating Specialized Education and Innovation:From the Perspective of Comprehensive Talent Cultivation[J].Journal of Higher Education, 2017(16):41-43+46.
- [3] Zhu Muzhi,Yuan Changrong,Chen Yu,et al.Research on the Construction of Specialized Innovation Integration Course Based on"Hydraulic Servo and Proportional Control System"[J]Tech Wind,2025,(03):31-33.
- [4] Zhao Jian,Zhao Zhiguo Research on the Practical Path of Integrating Innovation and Entrepreneurship Education with Professional Education in Local Undergraduate Colleges[J]Innovation and Entrepreneurship Education,2023,13(6):116-121.
- [5] Li Huadong,Xie Hu,Jiang Ning.Research on the Cultivation Model of College Students'Innovation and Entrepreneurship Ability:From the Perspective of the Governance System of Innovation and Entrepreneurship Education in University Departments[J]Innovation and Entrepreneurship Education,2022,13(6):46-51.
- [6] Qin Juanjuan.Teaching Reform of Hydraulic and Pneumatic Transmission Course with"Integration of Specialized Education and Innovation,Multi-level Linkage"[J]Modern Educational Equipment of China,2025,(01):139-141.
- [7] Che Junhua,Li Li Project-based Tutorial on Hydraulic and Pneumatic Transmission Technology[M].Second Edition Beijing:Beijing Institute of Technology Press,2021.1-7.