

Construction and Research on the Curriculum Package System of New Engineering Specialty Groups under the Threshold of Specialization and Innovation Integration

-- Taking Automation Majors as an Example

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Abstract

Under the background of the construction of new engineering disciplines and the "Double-High Plan", the in-depth synergy between professional education and innovation and entrepreneurship education (specialization and innovation fusion) is the key path to improve the core competitiveness of engineering talents. Taking automation professional group as the practice carrier, this study focuses on the real problems such as the disconnection between the traditional curriculum system and the industrial demand of new engineering discipline, the insufficient connotation of the curriculum structure of professional group, and the irrationality of the curriculum setting of dual-creation courses, and puts forward the proposal of the construction plan of the curriculum package system of the integration of specialization and entrepreneurship under the concept of "building an institute with a group". By integrating the technology and knowledge of the new engineering specialty group, the curriculum content system is reconstructed; by integrating the "six-dimensional integration" civic-political elements, the value leadership is strengthened; and by designing the "gradient cultivation of dual-innovation ability" course module, the whole process of specialized-innovation education is infiltrated. Research practice shows that the curriculum package system effectively solves the phenomenon of "two skins" between professional education and dual-creation education through modularized course clusters, project-based teaching resources and university-enterprise collaborative platforms, providing a new perspective and methodological support for the reform of the curriculum system of engineering professional clusters.

Keywords

Integration of specialization and creation; new engineering; curriculum package system; automation majors; reform of specialization and creation curriculum system; curriculum ideology and politics.

1. Significance of the Project

A new round of scientific and technological revolution and industrial change is accelerating around the world today. China's economic development is entering a new normal, and higher education is also entering a new stage. Since 2017, China's Ministry of Education has held a series of strategic seminars on the development of higher engineering education, and has held intense discussions on the engineering talent cultivation program in the new era, and has

reached the "Fudan Consensus", "Tianda Action", and "Beijing Guidelines" for the construction and development of new engineering disciplines. "Beijing Guidelines". At present, it is not only an urgent task for the country to cultivate a group of diversified, innovative and excellent engineering and scientific talents to provide scientific wisdom and talent guarantee for the prosperous development of national industry, science and technology, and economy, but also a long-term strategy. Colleges and universities should combine their own environments to accelerate the construction and rapid development of emerging engineering disciplines against the background of new economy and new industry development, and at the same time, actively construct a new structure of disciplines adapted to the combination of traditional engineering disciplines and emerging engineering disciplines. While exploring the new mode of engineering teaching and cultivation, students' innovation and entrepreneurship awareness should be enhanced, and a large number of new engineering talents should be cultivated for the country. At present, the important goal of higher education talent cultivation and the urgent need for the national implementation of the innovation-driven development strategy is to cultivate the innovation ability of college students. Among them, innovation and entrepreneurship education, which has a great promotion effect on the establishment and development of new engineering disciplines, has become a key link in the construction of new engineering disciplines in higher education. Colleges and universities have attached great importance to innovation and entrepreneurship education, and there are also a large number of research results, so it is obvious that the importance of innovation and entrepreneurship education is indisputable. However, how to efficiently implement innovation and entrepreneurship education in all local applied undergraduate colleges and universities under the background of new engineering disciplines is still a very challenging issue.

Compared with traditional engineering, "new engineering" emphasizes the cross-fertilization and practicality of disciplines, and focuses on upgrading and reconstruction to support the construction of emerging industries and traditional engineering majors. Whether for innovation and entrepreneurship education or professional education, the rise of "new engineering" is a new challenge, and colleges and universities around the world should cultivate a new type of high-quality talents with innovation and entrepreneurship spirit and in line with the demand of human capital market. Based on the theoretical research and teaching practice exploration of various parties, the construction of new engineering under the "integration of specialization and innovation" is not only an important opportunity to effectively solve the imbalance and insufficiency of innovation and entrepreneurship education reform and development, but also a key node to improve the quality and effectiveness of engineering professional education[1].

At the same time, the Implementation Plan for National Vocational Education Reform (hereinafter referred to as "20 Articles on Vocational Education") points out the trend and direction of the current development of vocational education. Higher vocational colleges and universities should take the initiative to adapt to the national strategy and regional industrial development needs, strengthen the synergistic development of professions, deepen the cross-border integration of professions, optimize the adjustment of professional structure, and strengthen the condensation of professional characteristics. Higher vocational colleges and universities should serve the needs of industrial transformation and upgrading and regional economic development, scientifically plan and steadily push forward the construction of professional clusters, and promote the construction of high-level professional clusters with the reform of the "Three Teachings", so as to drive the connotation construction of other professions and improve the quality of teaching.

Therefore, based on the education policy and industrial development, it is of great significance for the current higher engineering education to find out a set of professional course package

system that can meet the needs of the integration of specialization and innovation and the development of the new engineering discipline.

2. Synthesis of Research

2.1. The significance of implementing specialization and integration in new engineering majors

As an important intellectual support for regional economic development, local colleges and universities occupy a dominant position in the layout of engineering majors. Statistics show that more than 90% of local colleges and universities in China have engineering majors, and their core mission is to cultivate practical talents that meet the needs of regional industries. Such applied talents can be divided into three categories: engineering talents focusing on technical planning and system design, technical talents focusing on the implementation of technology in the production site, and skilled talents specializing in intellectual labor at the level of process operation. Under the background of industrial transformation and upgrading, as the demand for high-quality engineering talents with both technological innovation ability and market development consciousness continues to grow, local institutions are required to strengthen the synergy between industry and education, focusing on cultivating compound talents with technological improvement, process innovation and service optimization. By embedding the real projects of enterprises into the undergraduate training program, the adaptability of graduates to the regional economic development can be effectively enhanced, and the innovation and entrepreneurship effectiveness of talents serving the local community can be effectively improved.

At the present stage, the reform of new engineering education in local universities still faces multi-dimensional challenges, and is still in the exploratory stage in the supply of talent cultivation and the integration of specialized and creative education. In terms of theoretical teaching system, there is still no breakthrough in the traditional framework, curriculum innovation is insufficient, and there are few promotable teaching modes of expertise-creation integration; in terms of practical teaching, the practical links are out of touch with industrial needs, and most practical training programs are still limited to experiments for verification of teaching materials, and there is a lack of implantation of innovative elements in the real engineering scenarios; in terms of teaching resources, the ecological construction of dual-creation education is relatively lagging behind, and the on-campus faculty members are generally lacking in industrial experience. In terms of teaching resources, the ecological construction of dual-creation education is lagging behind, and the teachers on campus generally lack industrial experience. At the same time, there is a general cognitive bias in the student group, which equates innovation and entrepreneurship with business plan competition, and makes it difficult to transform professional advantages into innovation and practice ability. It is worth paying attention to the fact that the strong technical attributes of engineering majors is a "double-edged sword": professional barriers certainly enhance the competitiveness of employment, but overly focused on technical training instead of restricting the development of cross-field thinking. Based on the guiding framework of the State Council's "Implementation Opinions on Deepening the Reform of Innovation and Entrepreneurship Education in Colleges and Universities", local colleges and universities urgently need to combine their own problems and social needs, and take the concept of innovative and entrepreneurial thinking and the ability of college students' teamwork and cooperation as the development direction of the integration of new engineering majors and strengthen the cultivation of the integration of new engineering majors and entrepreneurship[2].

2.2. Study on the construction of professional clusters under the double-high program

As the strategic fulcrum of the "Double-High Plan", the formation of high-level professional clusters is based on the "disciplinary connection" of the majors within the clusters, and through strengthening the synergy of teaching between majors, the professional clusters and the industrial chain are maintained in an appropriate relationship. The essence is to build a shared theoretical knowledge framework and technical ability base, for example, all majors in the automation cluster need to master control theory, signal processing and other disciplines, but different majors show differentiated focus on the depth of knowledge and skill dimensions. The industrial robotics major focuses on the realization of motion control algorithms, while the intelligent detection major specializes in sensing data analysis, and there is a gradient difference in the weighting of PLC programming, Python application and other skill modules. The logic of "commonality foundation - characteristic extension" ability cultivation requires the professional group to break through the traditional single-subject teaching mode, build a new teaching organization system of "basic integration, direction streaming, project integration", through the dynamic reorganization of courses and teaching resources. Through the dynamic reorganization of modules and intensive sharing of teaching resources, it realizes the effective transformation of disciplinary connection to vocational ability, and finally forms the dynamic response mechanism between professional group and industrial demand[3].

As the core organizational unit of vocational education activities, the professional setting of higher vocational colleges and universities follows the law of disciplinary differentiation and occupational subdivision, aiming at cultivating compound skilled talents with the ability of integrating technologies in multiple fields. Under the development trend of industrial chain clustering, the construction of professional groups is based on the demand characteristics of regional industrial clusters for the spectrum of vocational competence, and higher vocational colleges and universities have constructed an education consortium oriented to vocational development competence through the systematic integration of multiple majors with technological relevance. This new organizational model needs to be based on the institutions' schooling accumulation and resource advantages, and at the same time emphasizes the restructuring of the curriculum system and the sharing of teaching resources, so as to strengthen the learners' flexibility of job adaptation and the resilience of career development. On this basis, the professional group through the construction of modular curriculum matrix, the establishment of school-enterprise collaborative education platform and other paths, to achieve the intensive allocation of teaching resources and the overall optimization of teaching effectiveness, and ultimately achieve a dynamic balance between the supply of technical and skilled personnel and the needs of industrial upgrading.

2.3. Construction of a specialized, creative and integrated curriculum package system under the concept of "building the institution by clusters".

With the deepening of the reform of higher vocational education, and the deepening of the connotation of the purpose of serving industrial development and economic and social development, higher vocational colleges and universities are paying more and more attention to the construction and development of professional clusters, in which the research on the construction and sharing of professional clusters' courses has been mentioned in a prominent position. Some scholars have put forward the strategy of adhering to the moderately autonomous "school-based" professional curriculum design, and establishing a close connection between professional teachers and professional courses that integrates the design, implementation and optimization of courses as a whole, which will become the main strategy of curriculum design for professional course clusters. In the context of professional group construction, it is necessary to integrate and optimize the allocation of curriculum resources.

The final point of this project is to study the design of suitable curriculum packages for electrical automation majors as an example, and to form a student-oriented "basic platform courses - professional basic/shared courses - specialized core/integrated courses - Capstone courses" system based on the concept of IEET international engineering education. "The system is based on the concept of IEET international engineering education."

3. Analysis of the Current Situation

3.1. Disconnection between traditional curriculum system and new engineering industry

The "14th Five-Year Plan for High-Quality Development of Manufacturing Industry in Guangdong Province" clearly puts forward that the new engineering industry represented by intelligent manufacturing, industrial Internet, high-end equipment, etc. will become the core driving force for the transformation and upgrading of the regional economy. As higher vocational colleges and universities directly connecting to industrial demand, the quality of their talent cultivation directly affects the appropriateness of the regional supply of technical and skilled talents. However, the current curriculum system of automation majors still generally follows the traditional engineering education model, and there is a significant gap between the speed of technology iteration in emerging industries and the demand for composite talents[4]. Similar problems are also prominent in automation majors, for example, traditional technology modules such as PLC programming and motor control still occupy the main body of the curriculum, while key technologies in new engineering fields such as collaborative control of industrial robots, digital twins, and edge computing are seldom involved. This contradiction between the lagging content of the curriculum and the cutting edge of industrial technology directly causes the structural disconnection of "learning is not for use". Take the "cloud-edge-end" collaborative control technology in the industrial Internet scenario as an example, although the Guangdong Provincial Planning will be listed as a key development area of intelligent manufacturing, but most colleges and universities are still relying on the traditional electrical control laboratory box for teaching, lacking in real production scenarios in the multidisciplinary collaborative practice. The disconnection between course content and industrial demand makes it difficult for students to cope with the demand for solving complex engineering problems in actual projects of enterprises even if they have mastered the basic theoretical knowledge.

3.2. Lack of substance in the curriculum structure of professional clusters

The construction of professional clusters needs to be based on industrial job competence mapping, through the analysis of regional economic structure and technology iteration prediction, and systematic planning of the adaptive path of talent training. However, there is a tendency of quick success and quick profit in the construction of professional clusters in some institutions. On the one hand, the logic of grouping deviates from the industrial ecology, overly relies on the existing professional resources on campus to carry out mechanical combinations, and ignores the ability of the upstream and downstream positions in the industrial chain to meet the needs; on the one hand, the curriculum system still follows the uni-specialty thinking, and fails to form a modularized competence matrix based on the industrial chain, for example, industrial robotics technology, Internet of Things applications and other courses in the intelligent manufacturing professional group are still separate, and lack of technological synergy in the design of teaching and learning; On the other hand, the reform dimension is fragmented, and the focus of construction is limited to superficial affairs such as deployment of teachers and updating of teaching materials, without establishing a dynamic adjustment mechanism linked with the advantages of regional industries. The root cause of this cluster

development mode is the systematic lack of top-level design - neither the construction of a curriculum framework for docking with industrial clusters, nor the formation of quality assessment standards for industry-education linkage.

The deep-rooted contradiction is even more reflected in the difficulties in the construction of the support system. The core value of the construction of professional groups lies in the cultivation of cross-border compound technical talents, which needs to rely on the systematic reconstruction of the "Three Teachings" reform. In terms of teaching team, the existing teachers are mostly confined to a single discipline background, and there is an urgent need to solve the bottleneck of insufficient teachers' cross-border teaching ability through the school-enterprise co-establishment of "technology+innovation" dual mentorship system; in terms of teaching resources, the traditional teaching materials are difficult to carry the characteristics of the rapid iteration of technology, and it is necessary to develop the loose-leaf manuals that are integrated with the real engineering cases, and synchronously support the virtual simulation and real training platform; in the level of teaching methodology, the majority of the classrooms still adopt the "technology point instillation" method, which is the same as the "technology point instillation" method. At the level of teaching methods, most classrooms still adopt the mode of "technology point instillation", and it is urgent to transform to the workshop-style teaching of "project-oriented and ability progression". Through the synergistic evolution of the "Three Teachings" reform, we can realize the qualitative leap of the professional group from scale expansion to connotation development[5].

3.3. Irrational and Inadequate Integration of Innovation and Entrepreneurship Courses

At present, the innovation and entrepreneurship courses in higher vocational colleges and universities are generally characterized by the structural problem of "focusing on theory but not practice". Most colleges and universities arrange innovation and entrepreneurship courses in the first year of college, with general knowledge content such as "Innovation and Entrepreneurship Fundamentals" and "Career Planning" as the main content, which can initially stimulate students' innovative consciousness but fail to form a deep connection with the subsequent professional teaching. Taking automation majors as an example, the innovation and entrepreneurship courses in which students are exposed to in the lower grades mostly stay in the shallow content such as thinking training and case analysis, and after entering the upper grades, when students gradually master the core skills such as PLC control and industrial robot programming, there is a lack of targeted courses to guide them to transform their professional skills into innovative practical abilities. For example, in the design of intelligent production lines, industrial Internet of Things system development and other complex projects, students need to combine professional knowledge and market demand for technological optimization or business model innovation, but the existing curriculum system is rarely set up in the "specialization and innovation fusion practice", "technological achievement transformation" and other higher-level course modules. However, the existing curriculum system seldom provides higher-level course modules such as "Practice of Specialized Innovation Integration" and "Transformation of Technical Achievements".

Under the background of new engineering, the demand for talents from industry has shifted from single skills to interdisciplinary integration and innovative application ability, but the fragmentation of the traditional curriculum system seriously restricts the realization of this goal. Existing professional group courses are mostly set up independently according to the logic of the discipline, such as Principles of Automatic Control focusing on algorithmic theory, Industrial Network Technology focusing on communication protocols, and Intelligent Manufacturing Systems favoring equipment integration, with a lack of synergistic design between courses. This mode of "fighting on their own" leads to the fragmentation of students'

knowledge structure and makes it difficult to cope with the comprehensive problems in real industrial scenarios. Take the typical project of intelligent manufacturing enterprises as an example - digital workshop renovation, which requires the simultaneous use of automatic control, data acquisition, cloud collaboration and cost optimization and other fields of knowledge, but due to the isolation of the course content in the teaching, students often only master a single point of technology, and are unable to systematically integrate the resources and put forward innovative solutions [6]. On the contrary, the actual needs of enterprises require technicians to be proficient in professional core skills, but also need to have the ability to transfer knowledge across courses, for example, in the operation and maintenance of industrial robots to integrate data analysis to predict equipment failures, or in the optimization of production lines combined with lean management thinking[7]. However, the existing curriculum system does not build a cross-curricular knowledge chain and ability chain, not to mention the cross-border thinking required for innovation and entrepreneurship into professional teaching, which ultimately leads to a disconnect between students' comprehensive literacy and industry. Therefore, it is necessary to reconstruct the teaching system with "curriculum package" as the carrier, integrate the curriculum content of professional groups through modularization, and break through the barriers between technology application and innovation practice.

4. Objectives and Issues to Be Addressed

4.1. Objectives of the subject

Implementing the "two unification and three integration" professional group talent cultivation model under the ecology of industrial colleges, and realizing the development goal of integrating professional education with innovation and entrepreneurship education. In order to innovate the traditional specialized and creative education courses, the single and independent dual-creative courses should be dissolved into embedded and reorganizable innovative and entrepreneurial knowledge modules, which can be integrated into various specialized courses, and build up the curriculum package modules under the viewpoint of "integration of specialization and creativity".

(1) Sorting out the curriculum package system - integrating the knowledge and job requirements of new engineering specialty groups

Sorting out the curriculum package system of professional groups, integrating the knowledge of new engineering and job requirements, and buttressing the development of industry, so that the curriculum can follow the new technology and serve the construction of professional groups.

(2) Construction of the curriculum package system - to create a level of specialized and creative integration, group courses through the curriculum

The positioning of the professional group and the characteristics of the electrical specialty in the new engineering situation, we create a system of "basic platform courses, professional basic/shared courses, specialized core/integrated courses and Capstone courses", and take charge of the electrical control course package of the professional group. At the same time, we have set up courses such as patent writing, dual-creation competition guidance, Capstone, and entrepreneurial project practice, realizing "subcontract sharing" and "specialization and creation through".

(3) Cultivation of the curriculum package system - Achievement of educational outcomes under the specialized and integrated curriculum package system

Through the practice of "subcontracting and sharing" courses of the curriculum package and "linking classes and competitions", these projects in the process of innovation and

entrepreneurship education are polished and cultivated in depth to form the educational achievements under the system of specialized and creative fusion curriculum package.

4.2. Problems to be solved

- (1) The problem of disconnecting traditional curricula from the development of new engineering disciplines and industrial needs;
- (2) The curriculum system of professional groups is scattered, and it is impossible to realize the mutual integration of professional group courses, which affects the effect of students' cultivation;
- (3) The traditional specialized and creative curriculum is unreasonable and not closely integrated, failing to integrate the knowledge of multiple specialized courses throughout the academic year, and lacking in courses on patents, entrepreneurial practices, entrepreneurial services, and other types of courses.

5. Research and Practice Content

5.1. Curriculum Studies

This project mainly studies the construction of electrical course packages for new engineering specialty groups in the field of integration of specialization and creativity. Course packages are not a new name for "modularization", and the course package system is not simply a combination of a number of "modular" courses. Curriculum package is a new course organization system, which not only has new connotation in course structure and content, but also is a new teaching organization mode, which is innovative at macro and micro levels, forming a new teaching management mechanism.

The research route of the subject is shown in Fig. 1 below, which is the content structure at the bottom, integrating the new knowledge, new technology and new jobs of the major group under the new engineering discipline to meet the needs of the students; on the basis of this, we build the shared basic courses and dual innovation courses according to the "subcontracting and sharing"; then, we build four major courses according to the industrial needs of the Pearl River West Bank; the Electrical As the automation major is an IEET international engineering education accredited major, this project also further sets up Capstone courses according to IEET; finally, the performance of competition, innovation and entrepreneurship is output through the curriculum package system.

5.2. Curriculum Content Development - Incorporating New Engineering Specialty Cluster Technologies and Knowledge

For the above combing system program, the course content is reconstructed. In view of the serious disconnection between traditional courses and industry, real enterprise cases are adopted as project-oriented, and project-based teaching content is formed "with the students as the main body". For example, the project of "Intelligent Distribution System Reversing Operation" in the following professional core course of power supply and distribution system operation and maintenance adopts the "Four New For example, the following professional core course of power supply and distribution system operation and maintenance, "Intelligent Distribution System Reverse Gate Operation" project, adopts the "four new" integration, i.e., the course project is docked to the new job requirements, the introduction of BRICS Future Competition project, the integration of new technology of intelligent power supply and distribution, and the compliance with the certificate standard of intelligent substation operation and maintenance, so that the course content meets the teaching needs.

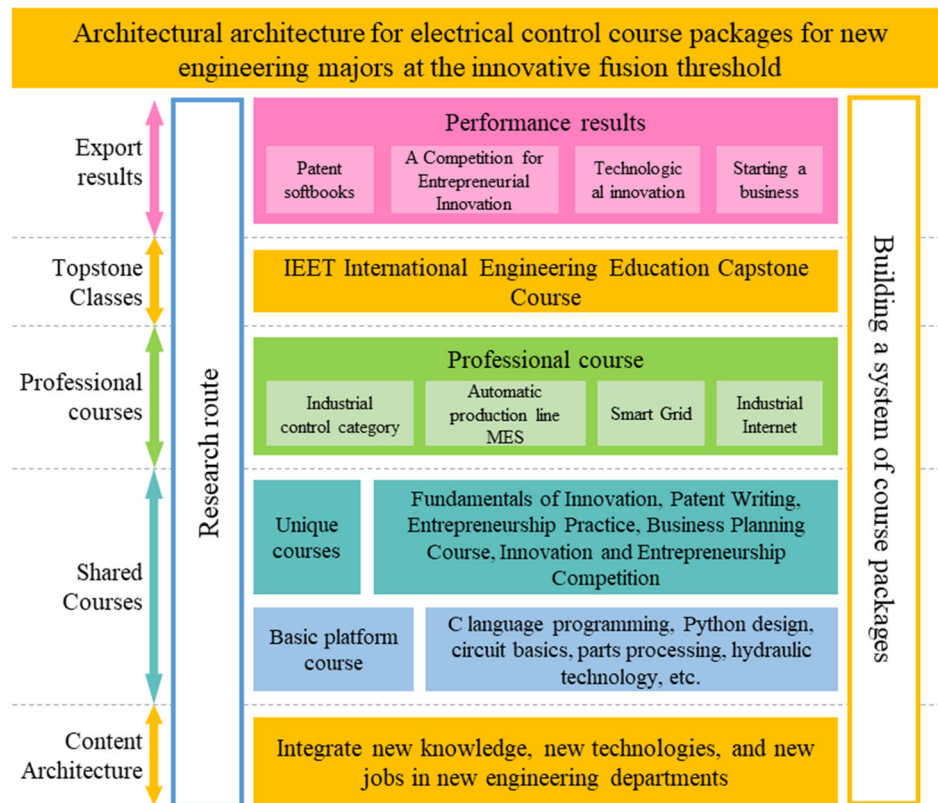


Figure 1. Curriculum including system architecture and research lines

5.3. Specialized Curriculum Development - Building a Deeply Integrated Dual Creation Curriculum

Aiming at the problems of irrationality and in-depth integration of the traditional dual-creation curriculum, build a dual-creation curriculum with in-depth integration (Figure 2 below). Creating rich and practical dual-creation shared courses throughout the three years of teaching in higher vocational education, cultivating students' ability to practice innovation and entrepreneurship, and at the same time, giving professional courses innovative and entrepreneurial elements, and ultimately Capstone courses outputting students' works, forming a perfect system of specialized creation courses.

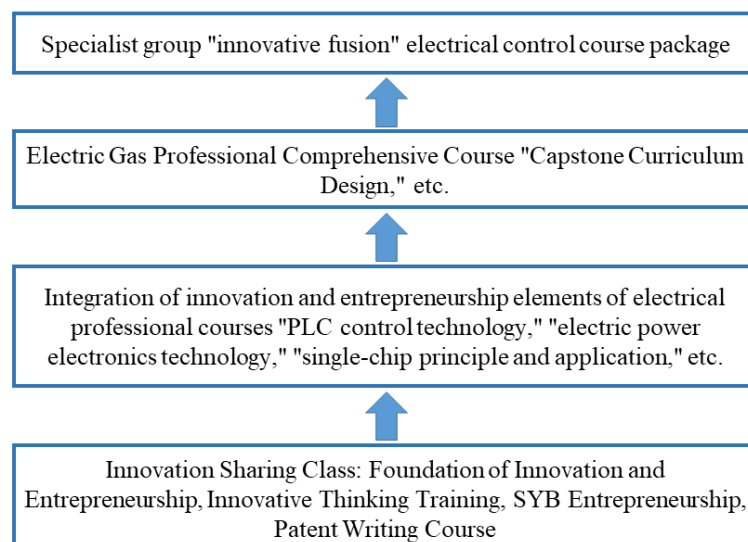


Figure 2. Specialized and integrated curriculum

5.4. Construction of Civics in the Curriculum - Construction of the "Six-dimensional Integration" Civics Element

Civic guidance, to help the construction of the curriculum package system, specific research measures from the "value guidance" and "conceptual norms" two aspects (two wings) to dig deep to produce a number of courses political material, to build a "six-dimensional integration, two wings fly in unison "The new model of the construction of course ideology and politics is constructed. Specifically, on the one hand, from the "science and technology for the country", "love and dedication", "life first" and other aspects of value guidance (the first wing), to cultivate humanistic feelings, set up a great ideal (to solve the problem of "who do it for"). (to solve the problem of "for whom to work"); on the other hand, the conceptual standardization (the second wing) is carried out from the aspects of "spirit of innovation", "striving for excellence" and "professionalism". On the other hand, the concept of "innovative spirit", "excellence", "professionalism" and other aspects of standardization (the second wing), to strengthen the professional foundation, enhance the sense of innovation (to solve the problem of "how to do").

6. Conclusion

In the context of the rapidly evolving global technological landscape and China's new normal economic development, this study delves into the critical path of integrating professional education with innovation and entrepreneurship education in the construction of new engineering disciplines. Taking automation majors as an example, we address the disconnection between traditional curriculum systems and the industrial demand of new engineering, the lack of substance in the curriculum structure of professional groups, and the irrationality of dual-creation course integration. By proposing a curriculum package system under the concept of "building an institute with a group," we have reconstructed the curriculum content system, strengthened value leadership through the integration of "six-dimensional integration" civic-political elements, and designed a "gradient cultivation of dual-innovation ability" course module to infiltrate the entire process of specialized-innovation education.

The research reveals that this curriculum package system effectively bridges the gap between professional education and dual-creation education through modularized course clusters, project-based teaching resources, and university-enterprise collaborative platforms. It not only provides a new perspective but also methodological support for the reform of the curriculum system of engineering professional clusters. Our findings underscore the significance of adapting higher education to the needs of industrial transformation and upgrading, as well as the urgent need to cultivate a new type of engineering talent with innovative and entrepreneurial spirits.

In summary, this study contributes to the ongoing discourse on the reform of engineering education by presenting a comprehensive framework for the construction of a specialized, creative, and integrated curriculum package system. By addressing the practical challenges faced by local universities in the context of new engineering, we hope to inspire further research and practice in this area, ultimately driving the innovation and development of engineering education in China.

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