

Innovation in the Three-Step Training pattern in Electronic Information Majors from the Perspective of the “Reform of Teachers, Teaching materials, and Teaching Methods”

Chunping Huang, Jing Sun

Zhongshan Polytechnic College, information engineering College, Zhongshan, Guangdong
528404, China

Abstract. The Reform of Teachers, Teaching materials, and Teaching methods” is a key approach to solve the problems of insufficient educational capacity and unsustainable development of major group resources. It provides strong technical and talent support for the upgradation of local major industries and high-quality economic development. It has become the mission of polytechnic colleges in the times. Zhongshan Polytechnic focuses on technology integration and application innovation of service enterprises, especially small and medium-sized micro enterprises. Centering on "independent learning, collaborative learning, and situational learning", it innovates the school enterprise cooperation mode, creates three major industry education integration support platforms of "innovation and cultivation center, studio, and research institute", and explores and constructs "three major categories of curriculum systems" driven by R&D innovative products that support the cultivation of three core professional abilities for talents in the electronic information industry. A competency oriented technical and skilled talent cultivation system has been established, forming a talent cultivation model of "integration of industry and education in three-step progression".

Keywords: The Reform of Teachers; Teaching Materials and Teaching Methods; Integration of Industry and Education; Third Order Progression; Talent Cultivation Mode.

1. Introduction

The "Implementation Plan for National Vocational Education Reform" and the "Opinions on the Implementation of the Plan for the Construction of High Level Vocational Schools and Majors with Chinese Characteristics" (hereinafter referred to as the "Opinions") point out the need to implement the plan for the construction of high level vocational schools and majors with Chinese characteristics (hereinafter referred to as the "Double High Plan"). The Chinese socialism is to always grasp the direction of socialist education and integrate the leadership of the Party into the entire process of university management and talent cultivation; High level education aim to provide strong technical and talent support for the upgrading of local major industries, and provide a driving force for high-quality economic development. Under the background of the “Reform of Teachers, Teaching materials, and Teaching methods”, Zhongshan Polytechnic College designed autonomous learning strategies, collaborative learning strategies and situational learning strategies to improve students' professional competitiveness. A new platform for the integration of industry and education has been established in the electronic professional group, consisting of three levels: "Innovation Education Center", "Studio", and "Research Institute". The platform focuses on the cultivation of three core abilities of talents in the electronic information industry, establishes a technical skill oriented talent training system, and forms a "industry education integration, three-level progression" training model.

2. Integration of Industry and Education is a Common Need for High-quality Development of Colleges and Enterprises

(1) The Integration of Industry and Education is the Mainline of the “Double High Plan”

Serving local industries and high-quality economic development, and cultivating a large number of high-quality skilled talents for enterprises has become the mission of vocational colleges in the new era. However, higher vocational education started relatively late, and the issues of how to offer courses and which talent training mode is suitable have been troubling vocational colleagues.

Copying the subject system to set up courses, completing practical training according to verification principles, conducting teaching behind closed doors, and using the talent cultivation models of other countries and schools have failed to effectively cultivate composite talents that adapt to the development of enterprises. The integration of industry and education provides an implementation path for the “Double High Plan”, becoming the main line for implementing the reform and development tasks of the Opinions. Deepen the integration of industry and education, establish a resource sharing platform, create a community with a shared future for schools and enterprises, and enable the sharing of technology, management, projects, processes and other elements of enterprises, as well as the intelligence and human resources of schools, through the platform; The joint participation of schools and enterprises in technology research, project development, product upgrades, and the promotion of deep participation in collaborative education among enterprises. The joint improvement of curriculum driven projects and training base construction by schools and enterprises, as well as continuous optimization of the curriculum system, is the only way for the development of modern vocational education system.

(2) Integration of Industry and Education is the Path for Innovative Development of Regional Enterprises

Talent is the decisive factor in the competitiveness of enterprises [4], and it is a way for brand innovation and development to improve international competitiveness. Taking the electronic information industry as an example, Zhongshan City, where Zhongshan Polytechnic is located, is located in the geometric center of the Guangdong Hong Kong Macao Greater Bay Area. The town's economy is active and the cluster effect is obvious, gradually forming regional characteristic industrial clusters such as ancient town lighting, electronic information in the Torch Development Zone, small home appliances in Dongfeng Town, sound and hardware in Xiaolan Town. It has a national level industrial base related to the electronic information industry, such as China's small home appliance industry base and national level lighting industry base, We have gathered over 10000 related enterprises supporting our industry, mainly small and medium-sized enterprises engaged in manufacturing and processing. With low profit margins, low product technology content, and low industrial technology barriers, our products are facing pressure to transform and upgrade towards personalization and intelligence.

The speed of technological iteration in the electronic information industry is constantly accelerating, and regional enterprises have an increasingly urgent demand for talents in the electronic industry who master technology integration, application, and R&D innovation. Many electronic small and medium-sized enterprises are unwilling to pay for talent cultivation due to their low profits in manufacturing and processing products. They urgently hope to accelerate the application of existing advanced technologies and innovative achievements by introducing high-quality technical and skilled talents or enhancing the ability of workers to master and use new technologies and processes. Therefore, small and medium-sized enterprises in this region hope to strengthen cooperation with relevant professional groups in schools, introduce the latest developments in industrial technology and process requirements, as well as the latest requirements for talent cultivation in the industry into the teaching process, and construct a curriculum system based on the needs of the industry. The enterprise projects are used as teaching content, and training bases are built according to the production workshop standards of the enterprise, allowing students to operate equipment in practical research and development to improve students' practical skills, reduce the cycle of adapting to enterprises, and solve the problems of difficult recruitment, employment, and retention in enterprises. In addition, small and medium-sized enterprises generally do not purchase expensive research and development and testing equipment, so establishing a positive interaction mechanism, and achieving win-win sharing of industry and education resources is valuable.

(3) The Integration of Industry and Education is the Implementation Path of High Quality Construction in Higher Vocational Colleges

Vocational colleges have shifted from simply pursuing scale expansion to moderate scale and quality improvement. The ability to cultivate high-quality technical and skilled talents suitable for

enterprises directly determines the brand and development space of vocational colleges. At present, engineering teachers in vocational colleges generally lack hands-on skills and practical experience from school to school, and are unable to develop a curriculum system that matches their professional abilities. They need to introduce enterprise projects and collaborate with enterprise engineers to participate in technical research and product development to improve project practical abilities; In addition, the practical teaching of engineering project-based courses is difficult to implement and has poor results. It is necessary to timely integrate new technologies applied by industry enterprises, build training bases according to industry enterprise standards, and timely eliminate and update old equipment and systems.

3. Building a New Platform for the Integration of Industry and Education with a "Three Step Progression" Approach

(1) Professional Ability Analysis

To develop a curriculum system that matches the professional abilities of the position, it is necessary to conduct research on electronic information industry enterprises, understand the demand and changing trends of technical and skilled talents in the industry, and clarify the requirements for knowledge, ability, and quality for the main vocational positions and job groups of vocational college graduates. After completing the research on the supply and demand of professional talents, it is necessary to analyze and extract the group of electronic information professional positions and their typical work tasks. The specific job tasks of the main job groups and the professional abilities required to complete the tasks are jointly designed by enterprise managers, senior engineers, and education experts to determine their abilities, knowledge, and quality structure, and determine core skills and related courses.

(2) Building a new platform for the integration of industry and education

After the above talent supply and demand research and professional ability analysis, three core professional abilities in the field of electronic information have been determined: electronic product drawing and assembly ability, electronic product testing and improvement ability, and electronic product software and hardware design ability. According to the needs of vocational ability cultivation, innovate the school enterprise cooperation model, and strive to utilize the school platform resources, faculty intelligence, and student plasticity as much as possible; By fully utilizing the advantages of the enterprise's familiarity with market demand, possessing project resources, understanding industry technology, and mastering process standards, a three-level progressive platform for industry education integration has been established, which includes "Innovation Education Center, Studio, and Research Institute". So as to, the professional abilities have gradually improved, as shown in Table 1. The knowledge involved ranges from a single discipline to interdisciplinary integration, requiring research and development abilities of teachers and students. The development experience gradually increases. The Innovation Education Center is guided by teachers and engineers, with students as the main body; The studio is hosted by teachers and general managers with experience in product development, with student participation; The research institute is led by experienced teachers and technical experts in product development, with student assistance. The three major platforms provide solutions for the source of engineering teaching practice projects, supporting the cultivation of three core competencies for talents in the electronic information industry. The three major support platforms of "Innovation Education Center, Studio, and Research Institute" provide excellent teachers and students to the top level, while the research institute provides project support and technical training to the bottom level.

1. Innovation Education Center Industry Education Integration Platform

The Innovation Education Center is composed of LED Lighting Education Center, Small Home Appliance Education Center, Audio Education Center, Electronic Information Education Center, and Internet of Things Education Center. Teachers choose an education center based on their development direction, choose cooperative enterprises, and select enterprise engineers as part-time teachers.

Teachers and enterprise engineers form a “diversified teacher team”, divided into several groups based on students' interests and foundations, such as software, hardware, and technology.

Table 1. Third-level Progressive Professional Ability and Docking Platform

Development stage and main docking platform	Occupation Ability	Job title	Typical job tasks of the post	Main post skills
III Institute	Hardware and software design capability of electronic products	system design	<ol style="list-style-type: none"> 1. Design the hardware circuit. 2. Design software programs. 	<ol style="list-style-type: none"> 1. Refer to the circuit diagram for secondary design. 2. Proficient in the advantages and disadvantages of various component specifications. 3. Ability to design analog and digital circuits. 4. Plan and design the system circuit. 5. Proficiency in programming languages. 6. Familiarize yourself with the drive frame. 7. Proficient in all kinds of basic algorithms. 8. Be able to carry out innovative programming.
II Studio	Electronic product testing and improvement capabilities	Quality control	<ol style="list-style-type: none"> 1. Test the quality of electronic products. 2. To formulate production specifications for electronic products to ensure the qualified rate of products. 3. Ensure that the product is certified. 	<ol style="list-style-type: none"> 1. Communication and coordination skills. 2. Ability to master and apply quality standards. 3. Skills in the application of quality control methods. 4. Understand the market access conditions of products and be able to improve products. 5. Develop production process instruction skills.
		Technical service	<ol style="list-style-type: none"> 1. Develop a pre-sales technical plan. 2. Carry out after-sales technical training. 	<ol style="list-style-type: none"> 1. Communication and coordination skills. 2. Ability to understand knowledge of electronic products. 3. Language and written expression ability.
		Product inspection and maintenance	<ol style="list-style-type: none"> 1. Detect the fault point of electronic products. 2. Repair according to the product failure. 	<ol style="list-style-type: none"> 1. Hardware map reading ability. 2. Maintenance and welding skills. 3. Instrument use skills.
I Innovation Incubation Center	Electronic product drawing and assembly capability	Product testing	<ol style="list-style-type: none"> 1. Test the product software. 2. Test the product hardware. 3. Debug the product hardware. 	<ol style="list-style-type: none"> 1. Software testing skills. 2. Hardware diagram reading and debugging skills. 3. Test instrument and instrument use skills.
		Equipment operation and maintenance	<ol style="list-style-type: none"> 1. Operation and maintenance of moulder, wave soldering and reflow soldering equipment. 2. Operation and maintenance of other assembly equipment. 3. Operation and maintenance of other electronic production equipment. 	<ol style="list-style-type: none"> 1. Welding skills. 2. Production equipment programming control skills. 3. Production equipment operation and commissioning skills.
		Circuit board designing	<ol style="list-style-type: none"> 1. Draw the circuit board diagram according to the schematic diagram. 2. Draw the circuit board diagram according to the products. 	<ol style="list-style-type: none"> 1. Hardware map reading ability. 2. Skill in using schematic and circuit board drawing software. 3. Circuit board design skills.

They mainly complete technology integrated product driven courses and undertake practical courses for innovation education centers. The Innovation and Education Center is equipped with computers, instruments and equipment, commonly used tools, and productive training equipment in

the training base supported by the central finance department. The mentor team and student group of the Innovation Education Center jointly develop technology integrated products, and transform or improve products developed or improved by the Innovation Education Center, studios, and research institutes into teaching driven projects. Students accumulate experience in project development practice, grow into technical backbone, and serve as team leaders to guide other students in practice in the classroom. Students can adapt well to the integration of "teaching, learning, and practicing" in professional courses through the cultivation of innovative cultivation centers.

2. Studio Industry Education Integration Platform

The studios are divided into master studios and enterprise studios. Master studios are national, provincial, and municipal level skill masters. Some of the enterprise studios are introduced from outside, while the other part is a company established by professional teachers part-time. The school provides free space for studios, preferential policies for water and electricity, the right to use research and testing equipment for enterprises, and priority recommendation for students' internships and employment. The studio produces products externally or engages in technology outsourcing services. Internally, a team of mentors is formed by the general manager or technical director of the enterprise, as well as teachers with experience in product development. Excellent students are selected from the innovation education center to participate. The studio mainly completes the development of technology application oriented product driven courses, undertakes studio practice courses, graduation comprehensive training, and on-the-job internships. Teachers and students jointly complete key technical research, product samples and inspections, and process optimization. The studio project practice course serves as a professional expansion course, allowing students to freely choose a studio and complete project tasks under the guidance of a mentor team. After completing the graduation design, students can obtain credits to replace relevant major courses.

3. Industry Research Institute Industry Education Integration Platform

The Research Institute is an automation research institute in Zhongshan City, which was founded under the leadership of the electronic information engineering technology specialty and approved by the Zhongshan Civil Affairs Bureau. The school provides free space for the research institute, preferential policies for water and electricity, and the right to use advanced high-end research and development and testing equipment for the research institute. The research institute is a technology innovation platform built for enterprises and majors, consisting of a team of experienced teachers and enterprise technical experts in product development. Top students are selected from the studio, and the enterprise provides information on technical needs and innovative product development needs. The research institute mainly completes the development of innovative product driven courses, undertakes practical courses for innovative product development projects, graduation comprehensive training, and on-the-job internships. Innovative Product Development Project Practice Course serves as a professional expansion course. Top students complete project tasks under the guidance of a team of mentors, and receive credits after defense to replace relevant professional course credits.

4. Innovative Talent Cultivation Model for Integrating Industry and Education

(1) Building a modular curriculum system

Based on the new integration platform of industry and education, with the goal of sustainable development of students, a curriculum system with a wide platform and a solid foundation that matches professional abilities has been constructed, taking into account both breadth and depth. Education relies on and serves industries and enterprises, relying on the new platform of "Innovation Education Center, Studio, and Research Institute" for the integration of industry and education, consisting of teachers, general managers of enterprises, technical directors, engineers, and students

The course team has developed course modules that serve key industries such as LED lighting, small household appliances, audio, electronic information, and the Internet of Things in Zhongshan, as shown in Table 2. According to the three core competency training needs of talents in the electronic information industry, the innovation and cultivation center connects with electronics

Ability in product drawing and assembly, completing the development of technology integrated product driven courses; The studio heads up test and improve electronic products, and has completed the development of technology applied product driven courses; The research institute has the ability to design electronic product software and hardware, and has completed the development of innovative product driven courses.

Table 2. College enterprise cooperation in developing curriculum modules for local key industries

Professional town	Professional direction	Course modules	Responsible person	
			Teacher	Enterprise experts
Guzhen town	LED lighting	LED light detection	Teacher 1	Incubation Center Engineer
		Design and Fabrication of Switching Power Supply	Teacher 2	Studio engineer
		Design of Smart LED Application Circuit	Teacher 3	Institute engineer
Dongfeng town Nantou town	Small appliances	Design and Fabrication of Control Circuit for Small Household Appliances	Teacher 4	Studio engineer
		Design and Fabrication of Control Circuit for Intelligent Household Appliance	Teacher 5	Institute engineer
Xiaolan town	Audio	Design and Implementation of Audio Power Amplifier Circuit	Teacher 6	Incubation Center Engineer
		Design and Manufacture of Digital Active Speaker	Teacher 7	Studio engineer
		Design and manufacture of gallbladder machine	Teacher 8	Institute engineer
Torch Development Zone	Electronic information	SMT Process Technology and Management	Teacher 9	Incubation Center Engineer
		Principle and Application of Stm32 Single Chip Microcomputer	Teacher 10	Studio engineer
		Intelligent Electronic Product Design	Teacher 11	Institute engineer
Huangpu town Guzhen town Xiaolan town	Internet of things technology	Wireless sensor network technology	Teacher 12	Incubation Center Engineer
		Application of Internet of Things technology	Teacher 13	Studio engineer
		Integration Design of Internet of Things Application System	Teacher 14	Institute engineer

(2) Innovate the talent cultivation model of "integration of industry and education, three-step progression"

Connecting with the professional ability of the post, focusing on the "independent learning strategy, collaborative learning strategy, and situational learning strategy", through the three-tier platform of "innovation and cultivation center, studio, and research institute", we have completed the development of three major curriculum systems, namely, technology integrated product driven, technology applied product driven, and R&D innovative product driven, to support the cultivation of three core competencies of talents in the electronic information industry, form a talent cultivation model of "integration of industry and education, and three-step progression". Freshman and sophomore students can choose to develop technology integrated products in different centers of the Innovation Education Center based on their interests and foundation, achieving personalized cultivation. At the Innovation and Education Center, the mentor team assigns project development tasks, and students form a team to explore independently according to task requirements. The mentor team guides and assists in completing relevant tasks. After assessment and defense, students with a

score of good or above can freely choose to participate in the development of technology applied products on the higher-level studio platform. In the studio, dual mentors and students form a project development team to jointly develop applied products for the market. Based on the completion of student tasks and defense, outstanding students can choose to participate in the development of innovative products on the platform of the previous research institute. At the research institute, students assist a team of mentors in completing new technology research and development.

All major courses focus on the design and production of typical products developed on a three-level platform, with projects as the carrier. Teachers must complete course driven project samples, textbooks, process files, and related teaching documents before the course starts. The course requires all students to complete the design or production of projects. Students operate in groups and are led by students who have undergone training in the "Innovation Education Center, Studio, and Research Institute", improved awareness of unity and collaboration. The course assesses students' performance, safety operations, whether typical work tasks have been completed, and the quality of completion. Key courses are taught jointly by full-time teachers and enterprise engineers, or are divided into modules based on their respective strengths.

(3) Strengthen target assessment and process evaluation

Integrating credit reform with the participation system of innovation education centers, studios, and research institutes, encouraging students to participate in practical project development, competitions, and patent applications. Students submit applications to guidance teachers based on their learning interests and foundation. Teachers clarify implementation plans based on project tasks, strictly manage the process, and after project implementation, project improvement, and project defense, passing the assessment can replace credits for relevant professional courses. Studios and research institutes can select students who have received training from the Innovation Education Center based on their abilities and preferences to conduct comprehensive graduation training, on-the-job internships, and even stay employed, complete product research and development, and provide teaching driven projects to the Innovation Education Center.

The "Innovation Education Center, Studio, and Research Institute" operates under the guidance of the School Enterprise Cooperation Development Committee of the school. It adopts an annual work goal responsibility system, which includes the development of cooperation projects, student training, dual teacher training, future cooperation needs and ideas, and other contents in the assessment. If the annual assessment fails, rectification must be made, and it will be re evaluated one year later. If the assessment fails for two consecutive years, an exit mechanism will be implemented.

5. Conclusion

Relying on the innovation education center, studio, and research institute industry education integration platform, we have recruited a group of skilled engineers from the industry to settle in, introduced a group of small and medium-sized enterprises to settle in, , and the project development ability of teachers has been improved. We have created a training base that integrates teaching, research and development, and social services, greatly improving students' hands-on practical skills and professional competitiveness. Through the practice of a talent cultivation model that integrates industry and education, with a three-stage progressive approach, teachers and enterprise technicians jointly develop courses, write textbooks that serve regional industries, and carry out teaching activities for students alternately in innovation education centers, studios, and research institutes, achieving effective integration between courses and positions, theory and practice, teachers and masters, classrooms and workshops.

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