ISSN 2663-8169 Vol. 4, Issue 4: 22-27, DOI: 10.25236/IJNDE.2022.040404

Exploration on the training mode of Innovative Talents for Characteristic Engineering in Architectural Colleges Driven by the Integration of Industry, Teaching and Research

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Abstract: *The construction of "new engineering" and "double first-class" is a powerful direction of national innovation-driven development and higher education reform. Based on the practical experience of teaching reform in shenyang jianzhu university Institute of Engineering Training and Innovation, this paper integrates various innovative elements, educational and teaching resources and platforms through the through the integration of Industry-Education and Science-Education, and forms a multi-element participation and multi-subject cooperation education mechanism, so as to truly integrate scientific research education and teaching education organically, improve the effectiveness of innovation and entrepreneurship education in colleges and universities, and cultivate innovative engineering leading talents with architectural characteristics that can adapt to social and economic development.*

Keywords: *New Engineering, Double First-Class, Multivariate Synergy, Engineering Innovation, Engineering Training*

1. Introduction

In order to adapt to the national and even international development needs of the new situation, scientific and technological innovation and industrial transformation need to take the initiative to deal with. For China, a series of national strategies such as supporting the innovation-driven development of economic services and "Made in China 2025" have been carried out. Fudan Consensus", "Tianda Action" and "Beijing Guide", systematically promote the construction of "new engineering" from many aspects [1]. The series of documents on the construction of "New Engineering" specifically emphasizes that it is necessary to reform methods based on students' aspirations and interests, and then through innovative engineering education methods and means to improve the degree of interest in the course and make the interaction between teachers and students more harmonious [2-3]. New engineering is an extension of traditional engineering, and it also reconstructs the discipline construction mode and development path of traditional engineering based on the new demand of new industry. It is no longer just subject oriented, but pays more attention to the needs of industry, and changes from a single major to a multidisciplinary crossover and integration [4]. Only by entering and going deep into the enterprise, integrating the advantages of enterprises, universities and research institutes, and forming a cluster-type and close-type integration model of production, teaching and research. Only by meeting the national strategic needs and jointly cultivating high-end, intelligent and top-notch engineering innovative talents and first-class and outstanding engineers, can we effectively improve the conversion rate of scientific and technological innovation achievements [5].

Based on the College of Engineering Training and Innovation of Shenyang Jianzhu University (hereinafter referred to as the "College"), this paper proposes to make full use of the comprehensive resources of the college to build a practical training platform with real engineering attributes.

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2. The Problems of Engineering Training Teaching in Colleges Driven by the Integration of Industry-Education and Science-Education

2.1. Teaching Content Is Far from the Frontier of Science and Technology, and the Update Is Not Timely

From the perspective of social demand, from the manufacturing in China to the creation in China, the society needs a large number of engineering innovative talents. The talents supplied by colleges pay more attention to the cultivation of theoretical talents in teaching materials, while the cultivation of engineering innovative talents is insufficient. In addition, teachers' participation in enterprise training is less, and their own scientific research progress is slow. Therefore, in some engineering practice teaching links, without introducing new knowledge and technologies into the teaching content, there will be some phenomena that the teaching content is outdated, teachers' teaching innovation is insufficient, and students' learning motivation is not high.

2.2. The Subject of Education Is Relatively Single, and the Awareness and Ability of Integrating Resources Are Not Strong

Although the college has built a teaching team for the course system and content, and established the teaching and research department for unified management, there is a lack of communication among the teaching teams, and the cohesion and continuity between courses are not enough, presenting a state of fragmentation. In the professional practical training courses, the cooperation with enterprises is not deep enough, and teachers' scientific research support is not enough, and they cannot integrate professional knowledge comprehensively, leading to the one-sided professional ability of students [6].

2.3. Poor Integration of Scientific Research and Teaching, Lack of Scientific Research Guidance, and Less Innovative Practice Results

Because the importance of scientific research to teachers' teaching and the cultivation of students' innovative ability is neglected, students lack research ability in science and technology. Although there are many students participating in scientific and technological innovation competitions such as "Internet+", "TRIZ Cup", and innovation and entrepreneurship projects for college students, they are not enthusiastic enough to participate and lack scientific research spirit, resulting in halfway and poor results. Although the college has put forward different teaching objectives for students of different majors, the practical content is basically the same, and there is a lack of differentiation.

Under the background of digital technology and Made in China 2025, the construction of "new engineering" and "double first-class" has become the main reform direction of school teaching construction [7]. At present, the problems existing in engineering training in our school are based on the integration of Industry-Education and Science-Education to improve the quality and innovation ability of engineering talents. The integration of Industry-Education and Science-Education, dual collaborative education is a new way of thinking and new format of engineering training reform in the new era. Through the integration and analysis of innovative resources and elements in various fields, the cross-integration and sharing of resources, technologies and services can be realized, so as to improve the level of scientific research to support personnel training, building a new model of collaborative innovation between industry and education, scientific research and teaching will surely improve the quality of engineering innovation talent training in architectural colleges [8].

3. The Conditions and Basis for Constructing a Dual Collaborative Education and Training Model of the Integration of Industry-Education and Science-Education

Shenyang jianzhu university Engineering Training Center was established in 2006, and is a directly affiliated institution of the school. In 2021, it was adjusted and integrated into an engineering training and innovation college, and was upgraded from a directly affiliated institution to a teaching unit. The existing teaching area covers an area of about 7,000 square meters. It has completed the teaching guidance tasks of engineering training for about 2,000 undergraduates (including international students) in 7 colleges (machinery, civil engineering, transportation, information, materials, environment and art), 24 majors, 72 classes, and some professional students' cognitive practice, production practice, open experiment, independent innovation practice and other teaching guidance tasks. With the merger of the Innovation and Entrepreneurship Center for College Students into the Engineering Training and

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Innovation College, the college has grown stronger, with an innovation and entrepreneurship incubation base of about 2,600 square meters, which can provide more than 1,100 sets of equipment for cultivating students' innovation practice teaching, pilot test of innovation achievements and transformation of innovation achievements. Through cooperation with the government and enterprises, the transformation of scientific and technological innovation achievements in the base can promote the transformation of productivity and facilitate the incubation of achievements.

In recent years, the college of Engineering Training and Innovation has undertaken and completed more than 20 national, provincial and ministerial scientific research projects, such as the "Twelfth Five-Year Plan" and "Thirteenth Five-Year Plan" National Key R&D Program, National Natural Science Foundation of China, National Science and Technology Support Program, National " 863" plan, international scientific and technological cooperation plan, etc. And scientific research projects are all carried out around construction industrialization, high-end ceramic bearings and high-end CNC machine tool motorized spindles. As our industrialization base, Shenyang Jianzhu University Factory, a high-tech enterprise of science and technology, is a school-run enterprise with decades of history of researching and manufacturing construction steel bar processing machinery. The main products include: steel bar straightening and cutting machine, steel bar hoop bending machine, high-grade stone processing center, ceramic motorized spindle, ceramic bearing, etc. The college has accumulated abundant high-quality practical teaching resources and discipline resources, and has made a series of achievements in specialty construction, talent training and teaching research. Among them, it has built provincial experimental teaching demonstration center, provincial engineering technology research center and provincial college students off-campus practical education base. The teaching team won the honorary title of "Advanced Collective of Education System in Liaoning Province" and "Special Contributing Collective of All-round Education" in shenyang jianzhu university, and made beneficial exploration and contribution to the cultivation of innovative talents in local universities.

4. Explore the New Dual Cooperative Education Mode of Integration of Industry-Education and Science-Education

4.1. Build a Dual Cooperative Education Mechanism of Industry-Education and Science-Education, and Correctly Understand Their Relationship

Relying on innovative practice platforms such as the Innovation Incubation Base of Shenyang Jianzhu University and the Pilot Test Base of Modern Building Intelligent Engineering Equipment, build a dual collaborative education mechanism of Industry-Education and Science-Education to achieve continuous training and gradual improvement of engineering innovation capabilities. The synergistic interaction and integration of various subjects in the integration of Industry-Education and Science-Education jointly effectively promote the overall development of higher education and economic society, and put forward various innovative elements and resources such as government, trade, industry, enterprise and high-level scientific research institutions, give full play to the collaborative innovation function of one plus one greater than two. Establish an organic connection between the college education chain, innovation chain, talent chain, trade chain and industry chain to achieve a win-win situation for multi-stakeholders. The process of educating people through the integration of production, education, science and education is shown in Figure 1.

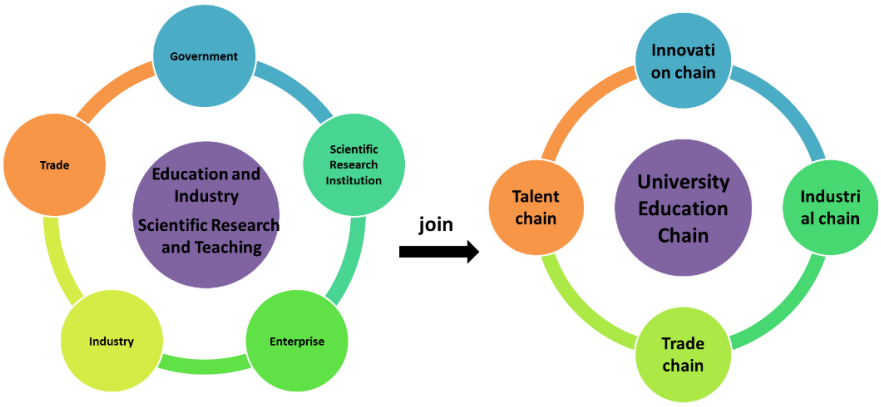

Figure 1: *The process of educating people through the integration of Industry-Education and Science-Education.*

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4.2. Highlight the Engineering Practice of In-Depth Integration of Industry-Education and Science-Education, Build a Modular Comprehensive Curriculum System

Embody the new engineering background in engineering training teaching, and pay attention to cultivating students' engineering practice ability. The engineering practice teaching system is established through new ideas, new modes and new means, which fully reflects the characteristics of the integration of Industry-Education and Science-Education from the teaching tasks, teaching processes and teaching results. The connotation of the deep integration of Industry-Education and Science-Education engineering practice is shown in Figure 2. Introduce some key technologies from industry-oriented advantageous scientific research projects into practical teaching, design practical training courses that integrate with scientific research projects, and create an ability-led curriculum system according to the different characteristics of disciplines in architecture colleges and universities. In line with the idea of setting up modular courses corresponding to scientific research projects for different majors, professionalizing teaching content, flexible teaching organization, open teaching process, and modernizing teaching methods, the curriculum teaching content and methods are reformed. Build a modular comprehensive curriculum system with outstanding strengths, distinctive features, interdisciplinary and inter-professional.

Figure 2: *Connotation of engineering practice of integration of Industry-Education and Science-Education.*

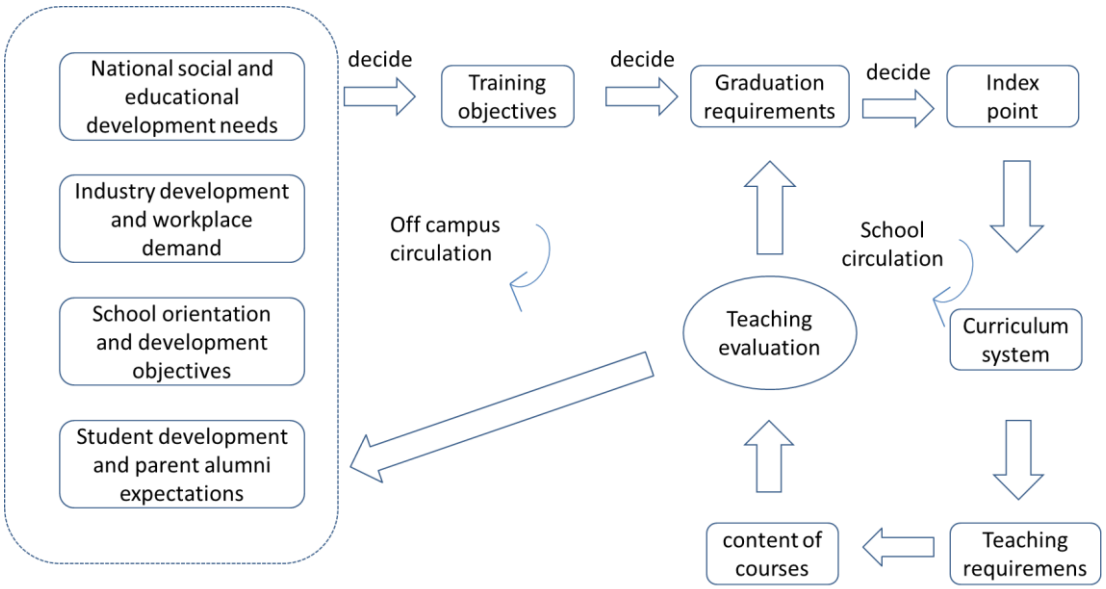

Figure 3: *Results-oriented instructional design process.*

ISSN 2663-8169 Vol. 4, Issue 4: 22-27, DOI: 10.25236/IJNDE.2022.040404

4.3. Highlight Student-Centered and Results-Oriented Teaching Philosophy

Deep integration of Industry-Education and Science-Education, innovative teaching concept of engineering training, and speeding up the training of new engineering talents. Breaking the traditional concept of curriculum-centered teaching design, according to the needs of enterprises for professionals, the OBE educational concept of student-centered, result-oriented and continuous improvement is carried out. Based on the goal-oriented, the teaching scheme with different contents, diversified levels and categories is constructed, which realizes the transformation from "others want me to learn" to "I want to learn". Multi-faceted integration of the development needs of countries, industries, schools and students begins, and the training objectives are determined by the needs, and then the graduation requirements are determined by the training objectives, and then the curriculum system is determined by the graduation requirements, and then the teaching requirements, teaching contents and teaching evaluation are determined, so as to realize the circulation inside and outside the school and form a closed-loop system. The result-oriented instructional design process is shown in Figure 3.

5. Conclusions

Under the background of "new engineering" and "double first-class", we insist on sharing resources and win-win interests of all participants in the integration community of Industry-Education and Science-Education, fully awaken the motivation of all participants, and broaden the ways of participating in engineering innovation practice education in colleges. Driven by the integration of Industry-Education and Science-Education, the practical education of engineering innovation responds to the demand for engineering innovative talents in the new era, further enhances students' professional level and creative thinking, cultivates students' awareness of self-employment, and helps students to develop career diversification and achieve innovation. Realizing the cultivation of innovative talents' scientific quality and innovative ability and promoting the supply-side structural reform of innovative talents cultivation in higher education engineering are of great practical significance to the current construction of "new engineering" and "double-first-class" universities.

Acknowledgements

Educational, teaching and scientific research projects of China Association of Construction Education (2021127), Liaoning provincial general higher education undergraduate teaching reform research project ([2021]254), Curriculum reform project of Shenyang Jianzhu University (kcgg202118).

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