

Rethinking of Innovative Development of Engineering Education in China: Based on the Case of a University in Shanghai

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Abstract Taking a university in Shanghai as an example, this study intends to analyze the problems affecting the innovation and development of engineering education in China through interviews with students, teachers, educational administrators and other different educational stakeholders, so as to explore a breakthrough path to solve the innovation and development of engineering education in China.

The study found that establishing a perfect engineering education system, continuing to implement the policy of opening education to the outside world, strengthening the international development of engineering education, effectively implementing the in-depth integration of production and education of engineering education, and carrying out the discipline construction of engineering education are the important realization paths for the innovation and development of engineering education in China.

Keywords: Engineering Education; Industry and Education Integration; New Vocational Education Law; Disruptive Innovation; Internationalization

1 Research Background

At the present stage, the quantity, quality and structural types of engineering and technical personnel in our country cannot meet the needs of economic and social development and industrial transformation and upgrading. Especially for strategic emerging industries, there is an urgent need to cultivate innovative engineering and technical personnel to break through the serious shortage of disruptive technological innovation and enterprise independent innovation.

This study is intended to focus on the case study of an engineering application-oriented university in Shanghai, and explore the implementation path of breaking through the innovative development of engineering education from the perspective of the innovative development of engineering education in China. This study tries to find solutions to the above problems.

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This research is supported by the Humanities and Social Sciences Youth Program of the Ministry of Education in 2020. The name of the project is the research on the mechanism of school education environment affecting doctoral students' career expectations from the perspective of social cognition. The project number is 20YJC880089.

Chinese engineering education joined "Washington Accord"¹ in 2016, in an effort to achieve a substantial equivalence between the ability of engineering graduates and that of the international community. Among the 12 abilities of graduates stipulated in the "Washington Accord", technical and non-technical factors are included in engineering education. The cultivation of these abilities falls within the scope of engineering education. The author believes that the internationalization of engineering education affects the innovation and development of engineering education. Washington accord is one of the ways to realize the internationalization of engineering education in our country. However, up to now, there are few works that discuss the innovation and development of engineering education based on the graduates' ability of Washington Accord. Therefore, from 2016 to 2022, the author conducted a series of interviews with students, teachers and education administrators in the form of courses and field research, combined with the internationalization of engineering education and the graduates' ability as stipulated in Washington Accord. Most of the questions set in the interview are the question options that the author thinks are related to the innovation and development of engineering education. These include macro aspects of educational governance, curriculum, views on internships or practical courses, views on full-time teachers, part-time enterprises and educational administrators, and career planning for undergraduates.

On the other hand, the problem of insufficient integration of production and education in engineering education has seriously affected the innovative ability of engineering talents and the innovative development of engineering education. However, combined with the provisions of the new vocational education law, the research on how to effectively implement the integration of production and education in engineering education is rare. Third, for a long time, the lack of research on engineering education in China has seriously affected the training of engineering innovative talents. At present, there is no research to analyze the innovative development of engineering education in China in combination with the current discipline construction of engineering education in China. Finally, how to find another way to solve the problem of stuck technology or key core technology and realize independent innovation of enterprises?

2 Problems of innovation and development of engineering education

2.1 The System of Innovation and Development of Engineering Education Needs to Be Improved

The basic education stage lacks the cultivation of higher-order thinking ability including critical thinking ability. Embodied in the system design can be listed as follows: the lack of relevant teachers, the lack of relevant courses, most of the teaching models belong to traditional teaching, and there is a problem of

¹ Accreditation <https://accreditation.org/accreditation-processes/accords/washington-accord>(March 19, 2023).Initiated in the UK by the Engineering Council, the Washington Accord, signed in 1989, is an international agreement among bodies responsible for accrediting engineering degree programs. It recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering.

simplification of teaching materials. The same problem also exists in the higher education stage, such as attaching importance to theory and neglecting practice, attaching importance to teachers' teaching and ignoring students' learning. The curriculum is unreasonable, the teaching mode is dominated by traditional lectures, and the teaching materials and training facilities lag behind the demand for engineering talents by industry development. Knowledge transfer and ability training of non-technical factors in engineering education are not in place.

The governance system of engineering education, including the evaluation system of resource allocation, supervision mechanism and quality supervision mechanism, has seriously affected the innovative development of engineering education. For example, "The Plan for Deepening the Reform of Educational Evaluation in the New Era" stipulated that "five evaluation criteria"² should be abolished. However, in fact, in the resource allocation of secondary colleges, the evidence used for evaluation is still awards, hats, titles, projects, papers, etc. It does not really set up the individual evaluation index of colleges and universities. Reflects the historical inertia of college evaluation thinking. There is no real personalized evaluation index for colleges and universities. It embodies the historical inertia thinking of university evaluation. And lack of innovative ways to break the historical inertia thinking. The reason is the governance of higher education. In the case of financial shortage in higher education, how to rationally allocate limited resources is a key issue to be discussed. Tracing back to its historical reasons, this problem can be said that most universities in China were state-owned and part of government agencies at the beginning of their establishment. Later, after the mid-1990s, the market-oriented policy of higher education resource allocation was gradually implemented (Yang, 2009). With the shortage of financial funds and the deepening competition of market-oriented resources, it is becoming more and more difficult for colleges and universities to obtain resources from the outside and redistribute resources on campus. However, it is mainly the government that evaluates higher education, and enterprises and society rarely participate in the evaluation of higher education, resulting in the lack of reasonable supervision mechanism for the allocation of higher education resources and the quality supervision mechanism of higher education.

2.2 Rules for Promoting the Policy of Integration of Production and Education Need to Be Improved

The new vocational education law, which came into effect on May 1, 2022, provides a legal basis and guarantee for the effective implementation of the policy of integration of production and education. However, there is a lack of detailed rules for guiding, encouraging, restraining and supervising the main

² http://www.moe.gov.cn/jyb_xxgk/moe_1777/moe_1778/202010/t20201013_494381.html.

Ministry of Education of the People's Republic of China (MOE) :The General Plan for Deepening the Reform of Educational Evaluation in the New Era issued by the CPC Central Committee and The State Council stipulated that the unscientific orientation of educational evaluation should be reversed, stubborn problems such as only grades, promotion, diplomas, papers and caps should be resolutely overcome, the ability and level of educational governance should be improved, and the modernization of education should be accelerated.

behaviors of various stakeholders in terms of laws and regulations. Therefore, top-level design and macro policies are difficult to implement. Although the policy of tax reduction and exemption for enterprises involved in the integration of production and education has been introduced, the situation of small implementation scope and low implementation is true. Only a small number of enterprises are recognized as the integration of production and education.

2.2.1 Lack of Coordination Mechanism

At the beginning of the enactment of the new Vocational Education Law, the implementation of the policy of integration of production and education only stipulated the tasks and responsibilities of relevant departments, and the supervision of their functions had no legal effect, so the implementation effect was not obvious.

2.2.2 Entrepreneurship and Corporate Social Responsibility Need to Be Strengthened and Brought into Play

In the regulation of corporate responsibility to society, participation in educational decision-making is not fixed as a kind of responsibility, and there is also a lack of mechanism to appeal to entrepreneurs, make them play their internal driving force, invest in education and participate in educational decision-making. Therefore, corporate social responsibility and entrepreneurship have not played their due role in education governance investment.

2.2.3 Educational Decision-Making Mechanism Needs to Be Perfected

The educational decision-making mechanism with diversified participants needs to be improved and perfected, and the role of economic and social organizations such as industrial enterprises in the educational decision-making mechanism needs to be strengthened

The new vocational education law calls for the implementation of multi-subject education, but it lacks detailed provisions on relevant laws and local regulations for industry enterprises and other organizations to participate in multi-subject education.

2.2.4 Effective Exchange Mechanism of International Organizations

In the design of top-level system, the communication and cooperation between organizations such as trade enterprise associations and international similar related organizations are neglected. At present, the exchanges and cooperation between China's industrial enterprise associations and other organizations and similar international organizations are mostly limited to technical exchanges or trade and cultural exchanges. Because there is no education committee or equivalent organization in China's industry enterprise associations and other organizations, it is impossible to carry out the functional exchange and cooperation of such organizations in serving economic and social development.

2.3 lack of Research on Engineering Education

At present, the number, quality and structural types of engineering and technical talents trained in China do not meet the needs of economic and social development and industrial transformation and upgrading. Especially for strategic emerging industries, there is a serious shortage of engineering and technical talents who can take on subversive technological innovation and independent innovation of enterprises. There are mainly the following reasons:

2.3.1 The Thinking Paradigm of Discipline Construction of Engineering Education Needs to Be Changed

Up to now, engineering education is mainly implemented according to the paradigm of scientific discipline thinking, but not according to the disciplinary characteristics of engineering education. It results in the fact that engineering and technical personnel pay more attention to theory than practice, or the characteristics of engineering and technical personnel training in science(Zhu, 2020). Engineering education has the connotation characteristics of technical factors and non-technical factors. In the past, due to the lack of scientific understanding of engineering education disciplines, its talent training model and scientific research paradigm fell into a single discipline. However, the research paradigm and thinking mode of a single discipline are difficult to realize scientific and technological innovation and solve complex and important problems.

2.3.2 Historical Reasons for Setting up Disciplines and Specialties

After the founding of New China, after learning from the Soviet Union and adjusting departments, there was a problem of too fine division of disciplines and specialties.

2.3.3 Engineering Education Reform Lags behind the Change of Knowledge Production Mode

Under the background of knowledge production mode 2, the implementation of engineering education needs the help of specific situations and the innovative combination of organizational carriers. However, due to the lack of close contact between industry and universities, the differentiated cognition of engineering talents training and the lack of close cooperation between schools and enterprises, the talents cultivated in universities lack practical experience and cannot meet the needs of enterprises, resulting in structural unemployment of graduates; On the other hand, the lack of applied R&D talents required by enterprises leads to the continuous low independent innovation ability of enterprises.

2.3.4 Lack of Education and Teaching Organizations to Train Engineering Teachers

For example, teacher education colleges and so on. Because engineering education has the connotation characteristics of interdisciplinary, teachers as the main body of teaching should also match it. However, most of the on-the-job teachers in engineering universities in China lack high-order thinking ability and

relevant training, so it is urgent to train a large number of engineering teachers.

2.3.5 Engineering Education Graduate Training against the Original Intention

The experience of developed countries proves that the employment rate of master's degree and doctor's degree in enterprises can improve the technological innovation ability of enterprises. Therefore, master's degree and doctor's degree graduates in engineering are set up in the engineering education system. The training of master of engineering and doctor of engineering should be based on real projects of enterprises and solve real problems in industry. The problem in China is that a large proportion of engineering masters and doctoral students are not. Its training mode is mostly academic postgraduate training mode, and most of the students are fresh graduates rather than social people, and diversified training has not been realized. It is contrary to the connotation and theme of the training of master of engineering and doctor of engineering.

3 Countermeasures and Suggestions for the Innovative Development of Engineering Education in China

3.1 Continue to Expand Education Opening to the Outside World

3.1.1 Strengthen High-End Leadership and Enhance China's Educational Strength and Innovation Capability

Through the introduction of world-class universities and specialty disciplines, joint training of high-level talents and joint scientific research, we should strengthen the construction of international frontiers and weak disciplines. Drawing on the advanced management experience of world famous universities, we will improve the internal governance structure, speed up the construction of a modern university system with Chinese characteristics, and boost the construction of first-class universities and first-class disciplines. By supporting institutions of higher learning to participate in major international scientific plans and projects, we should build a number of high-level international cooperative joint laboratories and international joint research centers, introduce high-level scientific and technological innovation talents to the world, and promote international collaborative innovation in science and technology in institutions of higher learning. By sending outstanding young teachers and academic leaders from institutions of higher learning to foreign high-level institutions for study and exchange, we will speed up the introduction of teachers from world famous universities, improve the system of professional standards for teachers, promote the qualification certification of foreign teachers, and speed up the construction of high-level teaching staff. Enrich the cultural exchanges between China and foreign countries and promote the mutual understanding of the people. Through integration, we should build a platform for high-level intergovernmental consultation on education, practical cooperation among professionals in the field of education, and friendly exchanges between teachers and students. We should improve the relevant systems

of the cultural exchange mechanism between China and foreign countries, create a number of cultural exchange brand projects between China and foreign countries, actively carry out international understanding education, and strengthen the construction of cultural exchange mechanism.

3.1.2 Develop Diversified Channels to Promote the Internationalization of Education

3.1.2.1 Achieved through Curriculum

International understanding education courses can be set up in primary and secondary schools, and foreigners living in Shanghai can be invited to teach or communicate internationally as teachers of international understanding education. The courses offered include language, culture, sports, art, etc. The forms advocate diversity. For example, it can be a theme combined with inquiry learning in the basic education stage, and it can also take the form of sports training or literary performance or children's games. In the stage of higher education, continue to encourage the establishment of inter-school friendly exchanges with foreign universities, and expand the cooperative relationship between applied universities and foreign enterprises, so as to provide students with opportunities to work or practice in foreign enterprises; Expanding the ways and channels for college students to go abroad, and continuously increasing the proportion of students studying abroad; In Shanghai's colleges and universities, the proportion of foreign students among undergraduates and postgraduates should be increased.

3.1.2.2 Encourage Citizens to Participate in International Friendly Exchanges

Non-profit organizations and individuals at home and abroad are encouraged to organize international exchanges and provide support in terms of funds and places. For example, non-profit organizations are encouraged to organize short-term study abroad, study tours or family visits. The state has issued relevant policies to give preferential tax policies to relevant groups and individuals. Such as through the use of foreign students in China or foreigners working in enterprises and institutions to communicate with local school students or citizens. This approach is also initiated by non-profit organizations led by the government. The government should encourage organizations to promote international exchange of volunteers and other activities; Encourage foreign students to establish network connections for international communication; Encourage people who have experience in international exchange to contribute ideas and suggestions for citizens' international exchange activities; Encourage the mutually beneficial exchange of education by making use of the existing sister city relationship between Shanghai and foreign countries. In addition, it will step up its efforts to publicize and develop the sister city relationship between the cities in the international education-first countries and Shanghai, in an effort to serve the internationalization of Shanghai's education.

3.1.2.3 Formulates Perfect Employment Measures

According to the policy of Shanghai's 2040 urban development plan on the living conditions of foreigners in Shanghai, formulate laws and policies to encourage foreign students graduating from universities in China to work in Shanghai, and attract high-end talents of foreigners to work in Shanghai.

3.1.2.4 Opens More International Schools

Additional schools or education and training institutions for continuing education for foreigners or for minor children who move with them should be set up, and efforts should be made to improve the quality of teaching in international schools. In the international education infrastructure, international teachers, international curriculum and other aspects of efforts.

3.2 Breakthroughs in Key Core Technologies

Through strengthening exchanges with international technology, education, talents, industry and enterprise organizations, we will improve our ability of independent innovation. The following suggestions are made.

3.2.1 The Role of Professional Certification in Engineering Education

Through the professional certification of engineering education or the development of other international educational, economic, social and other organizations, we will find another way to strengthen the cooperation and exchange with third countries or economies in industries and industries related to production, education, government and research. In order to achieve the above goals, we must first further strengthen the international engineering education professional certification of relevant majors. Strive to pass the relevant provisions in the professional certification of engineering education, improve the engineering education system and improve the quality of engineering education. It enables the trained engineering and technical personnel (engineers) to truly achieve international substantive equivalence, obtain employment qualification internationally and obtain employment in industries in the industry, (as a shortage of personnel) to flow, and even (cooperate) to innovate and start businesses. Facing the common problem of shortage of children and high-end skilled personnel in the world, the motherland has issued corresponding policies to encourage those with the ability to migrate to return to the motherland and make due contributions to the scientific and technological research and development of relevant industries in China.

3.2.2 Introduction of High-End Talents

Encourage researchers or high-end skilled personnel from third countries or economies to find jobs in China. Through the national or regional economic development strategic planning, research and develop-

ment personnel or high-end technical skills personnel with key core technology industries are introduced from third-party countries or economies. If we want to achieve this goal, we must deeply discuss and formulate the top-level system design plan for talent introduction as soon as possible and create a system environment for retaining talents.

3.2.3 Establishment of Relevant Organizations

Establishment of relevant organizations such as engineers' associations and industry education committees. For a long time, there has been a situation of "politics is cold and people are hot" in international political and economic relations. In order to carry out extensive and in-depth exchanges and cooperation with social organizations such as relevant economic industries in other international countries or economies, it is necessary to establish relevant organizations that are equivalent to them. Generally, the pursuit of profit maximization is the primary goal of an enterprise. In order to achieve the goal of maximizing profits, enterprises will find a new way under the circumstance that friendly development is not encouraged by the government. Relevant organizations, such as engineers' associations and education committee members within industry associations, will also be curious about relevant industries or relevant high-end technical and technical talents in China in order to seek their own development or perform their duties. Based on this, these organizations can carry out extensive and in-depth exchanges and cooperation, taking this as an opportunity to conduct technological research and public relations through organized scientific research and other forms.

3.2.4 The Role of Overseas Chinese Plays

Encourage overseas Chinese to contribute to the technological progress of the motherland. We encourage our students (scholars) studying abroad (for employment) or high-end skilled personnel with employment visas to take root in the countries where they study or in third-party countries or economies exporting technology (labor), and to export key core technologies to the motherland at an appropriate time. Maintain close contact and cooperation with local enterprises or scientific and technical personnel through long-term work or study in the place of employment. Establish long-term scientific and technological research and development cooperation and other links through scientific and technological public relations or beliefs with common interests and life values, and export the "stuck neck" or key core technologies of relevant industries to the country at an appropriate time.

3.3 The Establishment of the Board of Education

Legislation on Integration of Production and Education in Engineering Education and Establishment of Education Committee Article 8 of the New Vocational Education Law stipulates that "the State Council shall establish a coordination mechanism for vocational education to coordinate the work of vocational

education nationwide", which provides legal guarantee for the establishment of an education committee system in industrial enterprises. After the establishment of the intra-industry education committee, it can form a linkage with the relevant organizations of the vocational education coordination mechanism established in the State Council, and regularly feed back problems and report work to them through joint meetings and other forms to jointly discuss and implement the reform plan.

According to the new vocational education law, relevant laws and regulations have been issued, stipulating that the headquarters of the education committees in the vocational enterprises are under the direct leadership of the State Council, and the relevant regional branch organizations can be under the overall leadership of the headquarters organization or a special leading group established in the State Council.

3.3.1 The Role of the Party and Education Unions

Through strengthening the leadership of the Party and the role of education unions, the organization, leadership and supervision of the functions of the education committees within the industry and enterprises can be realized through the formation of multi-party cooperative governance ties.

Article 9 of the new vocational education law stipulates: "relevant departments in charge of industries, trade unions, mass organizations such as the China vocational education society, industry organizations, enterprises, institutions, etc. shall fulfill their obligations to implement vocational education, participate in, support or carry out vocational education in accordance with the law."

According to the provisions of the new vocational education law, the relevant laws and regulations have been issued to give full play to the superiority of the leadership of our party. Give full play to the role of the education industry authorities, education trade unions and China Vocational Education Association and other group industry organizations, to organize, lead and supervise the education committees within the industry enterprise associations.

3.3.2 Entrepreneurship and Corporate Social Responsibility

By giving full play to the spirit of entrepreneurship and corporate social responsibility, we will strengthen the establishment and functional implementation of the education Committee system within the industry.

Entrepreneurship can be divided into innovation and entrepreneurship(Zhang, 2022). From the top-level design, we should publicize and educate the entrepreneurs, and create a system design to educate the entrepreneurs, so as to guide the entrepreneurs to pursue the maximization of interests and at the same time form an internal driving force to promote social reform and make suggestions. In terms of system design, intra-industry education committees can serve as an important way for Chinese entrepreneurs to promote entrepreneurship, promote social development and change, and participate in educational decision-making.

3.3.3 Establishment of Duties and Functions of Social Organizations such as Industry Enterprise Associations

The education committee system within social organizations such as industry and enterprise associations may, in light of the characteristics of regional or local economic development, establish regional organizations and central unified organizations respectively, whose organizational functions are stipulated by laws, regulations or articles of association.

In terms of system design, a regional education committee alliance within a social organization such as an industry enterprise association can organize and contact the vocational education coordination mechanism established in the State Council, or form a linkage working mechanism through the national overall planning organization of the industry enterprise association.

The duties of the education committees in industry enterprises need to be fixed by legislation. The Ministry of Education, together with the Ministry of Human Resources and Social Security, the Human Resources and Social Security Bureau, the Ministry of Labor, the National Development and Reform Commission and other relevant departments, will discuss and formulate the basic duties of the education committees within the industry enterprises.

Industry enterprises regularly judge the development prospects of relevant industries, and on this basis, forecast and analyze the talent structure and types needed by the industry within a certain period of time; And investigate the quantity, quality, structure and type of the existing talent structure; These data are regularly released and fed back to various stakeholders through the co-ordination mechanism set up in the State Council for personnel training reform.

Research on the demand for talents by industry enterprises can be carried out in the form of think tanks. Each industry and industry takes the demand for talents for the development of regional economy and society as the guide, and maps out and makes a database of the talent cultivation status of relevant education and training institutions and feedback from employers in each region every year. Regular feedback is provided to the Education Committee of the industry corporate headquarters and relevant functional departments in the State Council.

3.3.4 Establish and Improve a Diversified Educational Decision-Making Mechanism

Relevant laws and regulations have been issued to establish, and perfect a diversified educational decision-making mechanism so that economic and social organizations such as industry and enterprise associations can play an active role in educational decision-making.

It can be implemented first in large and medium-sized enterprises or industrial enterprises above designated size, and its implementation experience will be gradually extended to the industrial associations of small and medium-sized enterprises.

Regular meetings of the Education Committee of the Industry Enterprise Association are held regularly, and the members attending the regular meetings, excluding the personnel of the permanent offices of the

Education Committee within the industry enterprises, shall be composed of the following stakeholders: For example: personnel of enterprises in other industries, personnel of educational administrative departments, personnel of educational and training institutions in schools, educational researchers in various institutions, front-line teachers, employees of enterprises, students or representatives of students, etc.

3.3.5 Top-Level System Design of Various Organizations

Establish a top-level mechanism design for communication and cooperation between industry enterprise associations and other organizations and international similar related organizations, and strengthen their cooperation and communication. Through the establishment of education committees in China's industry and enterprise associations and other organizations, and regular exchanges and cooperation with similar international organizations, to understand the changes in the demand for talents in the international market; And strengthen exchanges and cooperation in international certification of personnel training and technology research and development, to promote the effective implementation of our domestic policy of teaching integration.

3.4 Establish the Subject of Engineering Pedagogy

Suggestions on establishing a pilot project of engineering pedagogy discipline construction in engineering application-oriented universities. Contemporary knowledge production and discipline development have entered the era of interdisciplinary integration, which is not only the embodiment of the development of knowledge itself, but also the demand of human social development. Interdisciplinary integration is an important source of new disciplines, an effective way to cultivate innovative talents, and an inherent demand of economic and social development. The development of engineering education is facing new opportunities and challenges, and it needs the interdisciplinary development and multi-party cooperation to build "engineering pedagogy". The discipline construction of "Engineering Pedagogy" can make new contributions to the construction of a high-level engineering education system in the new era and the cultivation of outstanding engineering and scientific talents who are worthy of great responsibilities in the new era.

3.4.1 Establishment of "Engineering Pedagogy" in Engineering Application-Oriented Universities

The degree granting of engineering education in China is different from that in countries with advanced education. Before 2022, there is no educational institution that can issue engineering education degrees. In 2021, the State Council Academic Degrees Committee issued a notice on printing and distributing the Measures for the Establishment and Management of Interdisciplinary Subjects (for Trial Implementation), stipulating that universities that meet the requirements can set up pilot disciplines of engineering pedagogy. However, engineering application-oriented colleges and universities do not meet the require-

ments of setting up the pilot project of engineering pedagogy, and cannot award engineering pedagogy degrees. In view of this, this paper puts forward the suggestion of establishing a second-level interdisciplinary degree program of "engineering pedagogy" in engineering application-oriented universities.

Based on the characteristics of engineering education with technical and non-technical factors and different from the first-level discipline of pedagogy based on scientific thinking, it is suggested that engineering pedagogy should be piloted in some qualified engineering application-oriented universities. From the perspective of engineering pedagogy, a cross-disciplinary concept, "engineering pedagogy" is a science that takes the obvious educational existence such as engineering education practice and engineering education problems as the research object, aims at cultivating engineering education, management and research talents, and then explores the internal and external laws of engineering education. Then, academic research universities and engineering application-oriented universities are different in terms of personnel training, scientific research and social services, so the practical activities and problems of engineering education are also different. The types of engineers can be divided into scientist engineers, field engineers, industrial technology managers, etc. From the perspective of multi-type and multi-level training of engineering and technical talents, engineering application-oriented universities undertake the responsibilities of training field engineers and industrial technology managers. However, the number of engineering and technical talents trained by such universities far exceeds that of other types of universities.

3.4.2 Strengthen Industry-University-Research Cooperation in Engineering Education

Using the organizational model of knowledge production mode 2 to drive innovation and development, we should give full play to the interaction between engineering application-oriented universities and industries in economically developed regions to cultivate engineering and technical talents. Such as modern industrial college, which uses the carrier of deep integration of production. From the perspective of regional innovation and development of higher education services, Shanghai is located in the Yangtze River Delta, a gathering area of high-tech industries such as G60 Science and Technology Corridor, and also the location of the global science and technology center. The local characteristics of regional economic development's demand for engineering talents urgently need to explore and practice the cultivation of innovative engineering talents. It is imperative for engineering application-oriented universities in this region to participate in the pilot construction of the second-level interdisciplinary subject of engineering pedagogy.

3.4.3 Establishment of Discipline Construction Alliance

Establishment of Engineering Pedagogy discipline construction alliance in engineering application-oriented universities is needed. Alliance units include engineering application-oriented universities, uni-

versities authorized by doctoral degree programs in education, industries, enterprises and associations involved in the integration of production and education. Based on the pilot reform of new engineering construction in Shanghai, we will select pilot universities or disciplines in universities, and cooperate with universities with doctoral programs in pedagogy to build the discipline of engineering pedagogy. With the help of the policy of the Ministry of Education on the implementation of organized scientific research, we will encourage and support the construction of new engineering to form an engineering education alliance between universities or disciplines, and the alliance universities will take the lead in promoting the construction of a second-level interdisciplinary discipline of engineering education with universities with doctoral programs in pedagogy. Industries, enterprises, associations and other organizations that have cooperative relations with engineering application-oriented universities make personnel training plans, demonstrate courses, teaching materials and teaching methods, etc. In the discipline construction and personnel training, the pilot colleges and universities unite and condense the strength of all parties inside and outside the school, do a good job of synergy and demonstration, strengthen the theoretical and practical research of engineering education, drive more colleges and universities to explore the training law of engineering education talents, and provide theoretical support and talent support for improving the quality of engineering education.

References

- [1] Yang Y., An empirical study on Marketization and Equal Opportunity of higher education in China. Doctoral dissertation, *Niigata University*, 2009.
- [2] Zhu G.F., Engineering and Engineering Education Volume 1, *Higher Education Press*, 2020.
- [3] Zhang W.Y., Re understand entrepreneurship, *Hainan Publishing House*, 2022.