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INNOVATIVE MODELS AND PRACTICES FOR ENGINEERING AND TECHNOLOGY TALENT CULTIVATION IN TRANSNATIONAL HIGHER EDUCATION[1]

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ABSTRACT. ***Researches on engineering and technology talent cultivation in the context of transnational higher education (TNHE) mainly focus on how to adopt educational resources, how to improve the education scale and how to increase the social influence. There are not so many in-depth researches and practices about the TNHE models, professional construction and talent cultivation mechanism. This paper uses a qualitative research method and experience summary method to analyse Chinese engineering and technology talent cultivation models and proposes a Four-Dimensional Talent Cultivation Model in the trend of New Engineering Education (NEE) in China. The vital interests of the enterprises are raised, which ensures the enthusiasm of enterprises to participate in transnational education projects (TNEPs). The Four-Dimensional Talent Cultivation Model not only combines talent cultivation, scientific research and development, technological innovation and enterprise development together but also meets the basic requirements for the cultivation of engineering and technology talents in the context of globalisation.***

KEYWORDS: NEE, TNHE, engineering and technology talents, TNEP, talent cultivation.

JEL classification: I21, O31.

Introduction

The level of higher education is an important indicator of the status and potential of a country. At present, the reform of Chinese higher engineering education is standing at a historical turning point. In 2016, China proposed the concept of New Engineering Education (NEE), which means the upgrade of traditional engineering education, including such areas as intelligent manufacturing, cloud computing, artificial intelligence, and robotics (Wu *et al.*, 2017). Based on the ideas of integrating, coordinating and sharing, the purpose of NEE is to

cultivate interdisciplinary and innovative engineers who are strategic, innovative, systematic and open-minded so that they can respond to the rapidly-changing external environment and work in the future (Zhong, 2017). In the context of highly-developed economy and globalisation, the proposal of NEE provides a new perspective for developing engineering disciplines and makes new requests for the reform and development of engineering education in China. Furthermore, the implementation of NEE is also related closely to the goal that engineering education has to be put into international standards (Qu *et al.*, 2020). In this way, the role of transnational higher education (TNHE) plays an increasingly important role in higher engineering education in China. At the National Education Conference in 2018, Xi Jinping (2018), President of China, pointed out that it was necessary to accelerate the opening up of education and carry out high-level cooperation with world-class universities, which makes new opportunities for the development of TNHE, as well as makes new and rigorous demands for it. One form of TNHE in China is foreign universities cooperating with Chinese universities and launching their educational programmes or campuses in China to form transnational education projects (TNEPs) and institutions. They are part of China's educational opening up. Students can take the advantage of gaining knowledge from foreign universities but not actually going abroad. Through practices, many transnational universities in China have gained great success in the field of engineering and technology talent cultivation. For example, Wenzhou-Kean University explores new ways of improving the quality of talent cultivation (Fan, Guo, 2019). University of Nottingham Ningbo and Xi'an Jiaotong Liverpool University explore new mechanisms for the teaching staff's development (Gu, 2012). These successful examples show that the purpose of these TNEPs and institutions is clear and their role is getting more and more important in promoting education and teaching reforms and the construction of first-class universities in China.

With another round of enhancement of the opening up policy in education in China, it is noticed that the scale of TNHE has expanded rapidly and should be paid much attention to. TNEPs have gradually expanded from key and comprehensive universities to local application-oriented universities and higher vocational colleges. Till March 2018, there have been 2,572 TNHE institutions and projects in China, with nearly 600,000 students on campus (Zhang, Guo, 2020). It is reported that about 86% of the 137 "Double First-class" universities in China have launched TNEPs and institutions (China Education Online, 2020). And most overseas first-class universities that are committed to developing TNHE have already come to China to launch TNEPs. Therefore, the introduction of high-quality overseas resources has become stabilised (Zhang, Guo, 2020). However, there exist many problems in some TNEPs including insufficient high-quality resources, poor quality of teaching, low competence of disciplines, and the lack of connotative development mechanisms. With low student satisfaction and little attraction, many TNEPs meet the ceiling of development and some of them even cannot last (Xue, 2017). To further develop TNHE, universities need to respond to the structural changes during the reform and opening up in education. To promote the quality of TNEPs, the national department of education in China needs to organise the external quality assurance assessment and set up the exit mechanism so that the talent cultivation model of TNHE can be upgraded (Xue, 2017). As engineering TNEPs cover nearly 63% of the total number of TNEPs (Zhang, Guo, 2020), it is necessary to conduct the educational reforms and practices in TNEPs to enhance the talent cultivation quality in the context of NEE.

This paper aims at proposing innovative models of cultivation engineering and technology talents in China through analysing the ones that European universities adopt in terms of several key elements of talent cultivation, to solve the current problems China has in

engineering education. It provides the extra paths of engineering and technology talent cultivation, illustrates the specific ways to realise it, and proposes a Four-Dimensional Talent Cultivation Model for engineers.

It consists of five parts. The first part is an introduction. The second part introduces and analyses related literature on TNHE and cultivation engineering and technology talents. The third part analyses the typical models and characteristics of European engineering education. The fourth part proposes a Four-Dimensional Talent Cultivation Model and gives the related discussion based on the analysis of the Nanjing Institute of Technology's experience on engineering and technology talent cultivation. The last part is the discussion and conclusion.

1. Literature Review

The cultivation of talents in the field of engineering is a hot research field worldwide (Ojewumi, Fagbenro, 2019). In 2008, the European Society of Engineering Education established an Engineering Education Research Working Group and Australian Association for Engineering Education was also developing its group of educational research methods (Jesiek *et al*., 2010). In many countries, the researches of reform and innovation in engineering education are gradually being stressed (Jesiek *et al*., 2009a; 2009b). Nevertheless, the development of engineering education is entering a new stage lacking innovative researches and practices. Higher education is keen on observing the essence of education from the perspective of social needs. Teachers hope to cultivate the students into a successful path to their future career and help them adapt to changes in the economy and society. This leads to students' lacking awareness of the core of higher-level learning, independent learning ability and academic rigour (Murtagh, 2010; Crisp *et al.*, 2019).

Kangas *et al.* (2017) believe that most engineering students possess learning methods and the ability to pass exams, but lack the ability to study profoundly and extensively, which is one of the key factors affecting the quality of talents cultivation. Some students have no idea about the definition of engineering or the knowledge base required to get an engineering degree (Becker, 2010). In addition, studies on student autonomy and academic self-awareness show that personal self-efficacy, past academic experience and achievements will affect student transformation (Soom, Donche, 2014). This standpoint is widely supported and many studies have found a link among self-motivation, learning autonomy, and a positive transition to engineering education: the more motivated an engineering student is, the more qualified he/she is to be transformed into a member of higher education (Zhang *et al.*, 2004).

The differences in educational concepts and methods between countries lead to differences in students' ability to complete studies and develop competence. For example, the average graduation rate of university students is less than 50% in the USA whereas is over 90% in China. Chinese university graduate rate is evidently high because under the great influence posed by social and family factors, universities are usually more tolerable of students' performance (Wu *et al.*, 2016). Based on the current problems in engineering and technology talent cultivation, more and more universities are promoting researches and practical work in this field. For example, Durham University in the UK increased opportunities for students to cooperate with enterprises and society and raised students' understanding of engineering technology through practices. The Stanford University's study found that even if students acquire key transferable skills, such as the ability to communicate and socialise, they are unlikely to understand the relationship between these skills and engineering careers (Winters *et al.*, 2013). Therefore, contacts with enterprises can expand

students' cognition of careers and actively present an exciting future for young people. While improving their transferable skills during their university lives, they can also become qualified professionals working in the field of engineering technology through targeted training.

In China, engineering education develops at a high speed with the development of an industrial economy, and NEE has gradually become the latest concept of reform and innovation in engineering education. In February 2017, the Ministry of Education (MOE) of China held an engineering education development strategy seminar at Fudan University. Thirty universities participated in it and reached the "Fudan Consensus" (MOE, 2017a). After that, *the Notice of the Higher Education Department of the Ministry of Education on the Development of New Engineering Research and Practice* was released. In April 2017, a seminar on NEE was held at Tianjin University. More than 60 universities participated in and formed the "Tianda Actions" (MOE, 2017b). In June 2017, a team of experts formed the committee called "New Engineering Research and Practice" and held the first working meeting to comprehensively and systematically initiate the construction and development of NEE. More than 30 experts from universities, enterprises and research institutions reviewed and approved *New Engineering Research and Practice Project Guide*, which is usually referred to as the "Beijing Compass" (MOE, 2017c). These three important seminars and meetings are called the trilogy of NEE strategy which stands for the starting point of NEE and the beginning of the exploration of the innovative engineering and technology talent cultivation models in China (Shen *et al.*, 2020). Experts have a deep understanding of the shortcomings of current engineering education. Regarding cultivation high-quality engineers, Li (2017) believes that it is necessary to clarify the initial factors influencing engineers' growth. Engineers are not a subordinate to scientific talents. Only when science education is successfully transferred to engineering education, can real engineering and technology talents be cultivated. Qu (2017) believes that many problems exist in current engineering education. For example, there is a lack of clear standards for talent cultivation and the values of engineers and ethical education of engineers have been neglected. He argues that the training of teaching staff does not meet the requirements of modern engineering education and teaching staff's evaluation lays greater emphasis on educational background instead of their practical experience. Zhang and Wang (2016) point out that the problems in engineering education have caused engineering students' incompetency including the slow adaptation to working environment, weak humanistic and psychological quality, poor communication and practical ability, lack of independent learning, innovative ability and teamwork awareness. The students have little knowledge of the working procedures and business culture and cannot meet the requirements of social development.

Many universities in China have made meaningful explorations and attempts in NEE from theoretical discussions to real practices. For example, Dalian University of Technology cooperates with Sany Heavy Industry Group and Michelin Investment Co., Ltd. to implement the *Dagong-Sany Excellence Program* and *Dagong-Michelin Excellence Program* to cultivate application-oriented talents with engineering experience. It also establishes an "innovation experimental class" to cultivate top-notch innovative engineers, and an "engineering international class" to cultivate engineers with an international perspective (Zhu *et al.*, 2013). The Taiyuan University of Technology organises a pilot class to cultivate top-notch innovative talents "Experimental Class of Engineering Science and Technology Innovation" and implements a segmented model of "1.5+0.5+2", in which "1.5" stands for the 1.5 academic years of intensive teaching to educate students in humanities and natural sciences (Physics, Mathematics, English, Mechanics, Graphics, Computer Foundation, and a series of lectures on cutting-edge engineering technology, etc.), "0.5" stands for 0.5 academic year of

professional training to lay the foundation of discipline and train practical ability, and "2" stands for 2 years of customised training to enable students to focus on majors and participate in scientific research projects (Zhang *et al.*, 2012). From these successful experiences of exploring NEE, it can be seen that universities in China have already carried out the reform of the talent cultivation models at different levels and in different fields.

2. European Cultivation Model of Engineering Talents Analysis

European engineering education has been known for its long history and diverse models which have cultivated a large number of research-oriented and technology engineering talents. To be more specific, the universities of applied sciences in Europe provide diplomas directly related to vocational qualifications. The cultivation model of specialised talents enhances the adaptability of the graduates and enables them to play an active role in their professional and technical careers.

In European engineering education, the German Dual Educational System (as shown in *Table 1*) is very famous and productive. In this system, the entire talent cultivation process is carried out in factories, enterprises and national vocational schools (Andrä, Baethge, 2015; Ruediger, 2016). This cultivation model focuses on training in enterprises and combining theories with practices. The final goal of German engineering education is to cultivate qualified engineers. Those engineers must acquire relevant knowledge, skills and qualities during the learning and training processes in which the integration of theories and practices is heavily emphasised. When making the engineers cultivation curriculum, German universities take such factors into consideration as working position requirements, specialised field teaching requirements, requirements from the society and individual professional requirements. The courses are designed as General Basic Courses, Professional Courses and Engineering Practice Courses in which the Engineering Practice Courses usually take the form of internship in enterprises, seminars and lab project design. The topics of the seminars and the lab project design come from the real problems and questions which need solving. Therefore, the talents can involve deeply in the industry and get the experience of the business environment from the enterprises (Zuo *et al.*, 2018).

France pays special attention to the formation of students' comprehensive qualities and engineering practical abilities in its engineering education. A Big System (as shown in *Table 1*) that emphasises engineering training is formed through the cooperation among the government, universities, enterprises, students and third-party intermediary organisations (Tan *et al.*, 2019). In addition to the basic experiments and engineering training on campus, students also have six months of internship in enterprises. They can perform practical training in local as well as multinational enterprises. When French enterprises participate in university teaching, they do not only provide venues of the practical work but also provide students with the most practical, first-line skills training through the more in-depth integration of the engineers and managers from the enterprises. Furthermore, enterprises set up workshops on campus, and students can be familiar with the equipment and designing conceptual products under the guidance of the guest professors from the enterprises (Hou, Cai, 2019).

As a rising star of European engineering education, Finland has successfully established a Finnish-style university of applied sciences system with the Polytechnics System (as shown in *Table 1*) based on the experiences from Germany and other European countries. Till now, the polytechnic universities in Finland has cultivated a large number of high-quality application-oriented technical talents and has a great reputation in Europe (Liu, Tu, 2016; Lu, Wu, 2020).

Table 1. The Typical Engineering Talent Training Models in Europe

Country	Engineering Talent Training Model	Characteristics
Germany	the Dual Educational System	a model with long procedures in which the engineering education training be taken by universities
France	the Big System	a model with short procedures, in which the teaching and practising content being the core of the training
Finland	the Polytechnics System	a model with teaching-training dividing system

Source: Andrä, Baethge (2015), Ruediger (2016), Tan *et al.* (2019), Liu and Tu (2016), Lu and Wu (2020).

The European model of talent cultivation is inseparable from the enterprises (Lin, Hu, 2018). In 2003, the Finnish Parliament revised the *Polytechnics College Act*, which specifically emphasises that universities must establish close cooperation with enterprises and other universities (Lu, Wu, 2020). The teaching and research activities must be related to future work and regional development. The German government promulgated laws, regulations and implementation regulations such as *the Federal Education Act*, *the Enterprise Basic Law*, and *the Vocational Education Promotion Act*, which clarifies the responsibilities and obligations of government, enterprises and universities in talent cultivation. They are also the policy guarantees for the realisation of the German Dual Educational System (Wang *et al.*, 2017).

From the experience of the European engineering and technology talent cultivation, it can be concluded these models are successful in that they have clear goal and orientation for the talent cultivation. During the implementation process, they put more emphasis on the comprehensive knowledge system that talents should possess and on their practical ability training. Enterprises also take part in the process and a favourable environment is formed by the students, the universities and the enterprises.

3. Development of Cultivation Engineering and Technology Talents in China

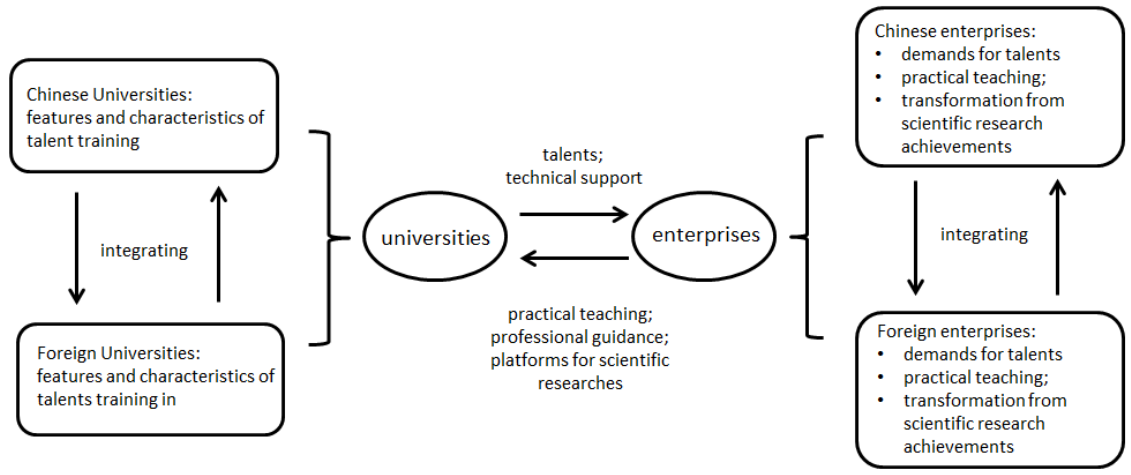
Yuan (2011), the executive director of the UNESCO International Engineering Education Center and deputy director of the Tsinghua University Council, stated that "Although the overall scale of engineering education in China is the largest in the world, the structure needs to be optimised and the quality needs to be improved". Some experts point out that China's engineering education has three major problems: the dislocation of talent cultivation model, the absence of engineering ethics, and the disconnection between engineering education and professionalism (Yuan, 2011; Wang, Yu, 2011). The "Fudan Consensus" points out that China needs to learn from international universities in the implementation of NEE. The international ideas and standards need to be combined with Chinese ones (MOE, 2017b). Therefore, TNHE provides an important way for Chinese universities to adopt the advanced international experience of talent cultivation.

Nanjing Institute of Technology (NJIT) will be analysed in the following part as an example. As early as the 1980s, NJIT started the international cooperation and cultivation of engineers, cooperating with institutions in German including the Hans Seidel Foundation and German Technical Cooperation Corporation, etc. At that time, some universities of applied sciences in Germany gave counterpart assistance to four universities in China. With the support from the former Ministry of Machinery Industry in China and the government of Baden-Württemberg in Germany, NJIT established the Nanjing CNC Training Center, one of the earliest units developing and producing CNC machine tools in China. Since 1988, learning from the experience in Germany, NJIT has successively cooperated with Jiangsu University of

Technology and East China Institute of Technology to train undergraduate talents. It is one of the first universities to carry out the professional teaching reform in China called S*mall-scale and Large-promotion*, to pilot the "3+1" undergraduate teaching mode, which means three years of theoretical study at the university and one year of practice in enterprises, and finally to explore new ways of training high-tech application-oriented talents. In 1997, NJIT established the "Siemens (Nanjing) Automation Technology Training Center" in cooperation with Siemens in Germany. In 1998, it cooperated with the German government to build the "Nanjing Automation Higher Vocational Education and Training Center" project. In addition, Hefei College of Anhui Province and the universities of applied sciences in the former Federal State of Lower Saxony also established educational cooperation and jointly launched TNEPs. Since then, major universities in China successively promote cooperation cultivation mechanisms with foreign universities or enterprises.

However, there are two problems in TNHE currently in China. One is that some enterprises fail to truly participate in talent cultivation and some who can get involved lose confidence in the investment and return because of the lack of a sustainable return. The other is that some TNEPs only provide a period of education and prepare the students to get enrolled in foreign universities and institutes, without an in-depth cultivation model of talents. This pattern cannot satisfy the needs of engineers in Chinese society. Therefore, TNEPs need to review the model of talent cultivation and new elements need to be incorporated into the cultivation system to have it upgraded.

It is one of the urgent needs in China to learn from the cultivation model of engineers in Europe and cultivate talents from international perspectives through the implementation of TNEPs. Therefore, in the context of NEE, Chinese universities should break through the TNHE model featuring cooperation between Chinese and foreign universities, and upgrade the model into a four-dimensional one featuring the cooperation among foreign universities, foreign enterprises, Chinese universities and Chinese enterprises, as proposed in *Figure 1*.



Source: created by the authors.

Figure 1. **The Four-dimensional Talent Cultivation Model**

The Four-dimensional Talent Cultivation Model (as shown in *Figure 1*) aims at seeking win-win situation and common points among multiple parties, instead of simply adding the parties together, so as to realise the sustainability. Providing students with opportunities to be educated and cultivated overseas help promote the teaching quality of

TNEPs and provide more solid support for the quality of talent cultivation. Involving Chinese and foreign enterprises in the process and making them part of the main bodies of education not only provides each party with international talents and human resources but also builds a shared platform for the interactions and cooperation among the four parties in markets, products and R&D technologies. In this way, the enterprises' interests are combined with the cooperation and then the participation can be ensured. In the meantime, foreign universities can also benefit from the technical and cultural exchanges and even share the job market with Chinese universities.

The Four-dimensional Talent Cultivation Model is an innovative localisation of European engineering talent cultivation model, with reference to the current situation of Chinese engineering talent cultivation under the proposal of NEE. The specific operational mechanism of the Four-dimensional Model is shown in *Figure 1*. Firstly, Chinese universities cooperate with Chinese enterprises. Chinese universities provide talents to Chinese enterprises, and Chinese enterprises provide these talents with practical training environments. Secondly, Chinese universities cooperate with foreign universities. Both parties can draw on the strengths of teaching mode from each other to make up for their own weak points in education. Thirdly, Chinese universities cooperate with foreign enterprises. Talents who can adapt to the market and are especially familiar with Chinese market needs are provided from Chinese universities to foreign enterprises and foreign enterprises provide these talents with foreign practical working environments and business culture. Fourthly, Chinese enterprises cooperate with foreign enterprises. With the cooperation between the universities from both parties, enterprises can cooperate in accordance with local and foreign market changes. Fifthly, Chinese enterprises cooperate with foreign universities. The qualifications of talent cultivation are provided from Chinese enterprises to foreign universities, and Chinese universities provide Chinese enterprises with an adequate cultivation mode. Lastly, foreign universities cooperate with foreign enterprises. Talents are provided from foreign universities to foreign enterprises, and foreign enterprises provide foreign universities with the practical working environments they need.

From the above description, the core of the innovative model is the cooperation between universities (the integration of the teaching concepts, teaching experience and teaching models from Chinese and foreign universities) and enterprises (Chinese and foreign enterprises). Specifically, there are three types of cooperation. First, Chinese and foreign enterprises form a complete talents demand system when they cooperate together; second, Chinese and foreign universities form a complete talent cultivation system together; third, the in-depth cooperation is conducted between universities and enterprises based on the first two types of cooperation.

3.1 Cooperation between Chinese and Foreign Universities

Chinese and foreign universities are the main bases for talent cultivation. They should share resources and learn from the strengths of each other as this is the basis for the formation of a comprehensive, compound and interdisciplinary cultivation system. In fact, both Chinese and foreign universities have their own advantages and characteristics in the cultivation process of engineering talents. During the cooperation, some objective factors influencing development can be avoided such as small scale, few majors, inappropriate university-running mode, and single talent cultivation mode. The in-depth cooperation in talent cultivation and scientific researches between Chinese and foreign universities shows a diversified trend in the form of cooperation, the cooperation content, and the cooperation focus. They try to broaden

the horizons of development and enhance the innovation in engineering universities through comprehensive and three-dimensional cooperation. Besides, a new platform can be built for innovative and cooperative activities between the universities. The boundaries of traditions can be broken to help students apply knowledge of different disciplines to practice, to solve problems, and to improve research and innovation abilities. The talent cultivation system fully integrating Chinese and foreign universities' characteristics will better meet the needs of the engineering field for comprehensive talents who can master new technologies and interdisciplinary knowledge.

3.2 Cooperation between Chinese and Foreign Enterprises

The transition from de-industrialisation to re-industrialisation in some developed countries further illustrates the core position of the real economy in national economic development. The real economy is supported by a large number of engineering talents. Thus the reform and development of engineering education should have a strategic position in national development. The core of higher engineering education cannot simply be regarded as the emphasis on engineering practice but on students' various abilities including professional and non-professional abilities such as the adaptability to economic development and engineering practical ability.

In the cooperation with foreign enterprises, Chinese enterprises study the advanced concepts and experience, such as the innovation and entrepreneurship training model jointly developed by the leading universities, governments, and industries, and the new organisations including university science parks, incubation centres, innovation centres, to provide a real and effective platform for university students' practical education. This is consistent with the appeal of a coordinated platform to cultivate talents delivered by the Ministry of Education in China: to widely build innovative and entrepreneurial platforms such as entrepreneurial incubation bases, scientific and technological entrepreneurship bases and maker spaces. China now lays great emphasis on the concept of C*oordinated Education* with support from the development of policies, industries, education and researches, trying to merge the training of entrepreneurship into the whole process of talents cultivation (Yang, Yang, 2018). In developed countries, the role of general education is more emphasised in talents cultivation because the future engineers must use engineering principles, knowledge and skills, and go beyond the boundaries of engineering to understand the world to solve social problems possibly caused by non-engineering factors. Future engineering disciplines will become more interdisciplinary and will require a comprehensive understanding of general education. Besides, future engineers will face more adjustments and changes in positions, occupations, and even industries. A good grasp of general knowledge will equip them to meet the challenges. All the future changes and requirements mentioned above are worth exploring for Chinese enterprises. In this way, a complete talents demand system can be developed by integrating the advanced concepts and experience from foreign enterprises, and the way for in-depth university-enterprise cooperation can be paved.

3.3 Cooperation between Universities and Enterprises

The in-depth cooperation between universities and enterprises includes a complete theoretical system on talent cultivation model and various forms of university-enterprise cooperation practices.

From the perspective of talent cultivation model, the engineering courses at universities should pay close attention to the actual needs of the business community. They should be based on the analysis of enterprises' status quo, the future development trend of technology and products. Experts from relevant industries should be invited to participate in the design of the curriculum. Course learning is generally divided into two stages: the basic learning stage and the professional learning stage. The practical courses are placed in the professional learning stage, and the content, methods and assessment of the practice are jointly decided by universities and industries. Students can only be considered as receiving a sound education in both theory and practice after completing the basic and the professional learning stage covering a large number of engineering practices. From the perspective of the construction of NEE disciplines, an autonomic and flexible major setting is favourable to implementing the ideology of facing the industries and the future, as compared to governments, universities are better at grasping market needs and promoting closer connections and cooperation between universities and industries (Yang, Yang, 2018). However, the autonomy and flexibility of major setting add more responsibilities to universities in talent cultivation. First, it is necessary for universities to accurately predict the current and future demands for talents in the industries along with the economic and social developments and to set up the majors accordingly. Second, universities must dynamically adjust the existing majors and cultivation programmes timely to ensure that the talents are not lagging but ahead of the needs of the market. Third, universities must directly face the intense competition in the free market of talents and focus on the advantages and characteristics in major setting and talent cultivation.

There are various forms of university-enterprise cooperations, which should not be limited to the cultivation of talents, as well as the cooperation in scientific researches. This is because enterprises are mainly providers of educational resources. In cooperation with universities, enterprises can recruit engineering and technology talents according to their own needs and get opportunities to provide continuing education and on-the-job training for their employees. However, the costs of enterprises are far beyond their gains. Therefore, in the cooperation between universities and enterprises, universities should also pay attention to cooperative scientific researches and the transformation from research achievements to actual productivity, so as to provide enterprises with as much return as possible. Only in this way, can a win-win situation be achieved.

There are two main ways of cooperation between universities and enterprises including the talent exchanges and jointly constructed research institutes and laboratories. The universities can hire senior engineers with front-line working experiences from enterprises to be the emeritus professors, which can be regarded as an acknowledgement of personal abilities and status in enterprises. In this way, the senior engineers can actively be part of these exchanges. Besides, universities can set practical education as part of engineering education, or students can have internships in enterprises to form a continuous and complementary relationship between universities and enterprises. For example, the undergraduates are required to complete at least 6 months of internship which can be divided into two stages, basic internship and professional internship, each of them lasting for 3 months. Enterprises are also willing to accept students to carry out scientific researches or

practice as most enterprises regard it as their own social responsibility and obligation. Many students' graduation projects should also originate from actual enterprise experience. In the research institutes and laboratories jointly built by universities and enterprises, engineers from enterprises should occupy a considerable proportion. Each research institute could have a professional steering committee in which the chairman also comes from the enterprise. This approach can stabilise the connection between universities and enterprises, improve the overall level of engineering education in universities, and keep it at the forefront. At the same time, the approach can also enhance the scientific research capabilities of enterprises and provide the engineers with opportunities for continuing education.

On the one hand, universities provide enterprises with talents and technical support through the utilisation of high-tech scientific research talents, advanced theoretical research results and technical equipment. They can also provide services to enterprises by supporting the research and development of products, reducing production costs, improving production efficiency, and innovating management methods. On the other hand, enterprises send experts with rich practical experience to participate in teaching tasks, provide financial support and training venues for scientific research projects in universities. This new integration mode combining talent cultivation, scientific research and development, technological innovation and enterprise development has achieved a win-win situation for universities and enterprises and is in line with the requirements of economic globalisation and market competition for cooperation and innovation.

Conclusions

This paper discusses the elements, participants and implementation path of the engineering and technology talent cultivation model in the context of TNHE. From the perspective of cultivation process of engineering and technology talents, the content should be expanded from simple knowledge teaching to interdisciplinary knowledge integration, and from theoretical learning in class to the expansion of engineering content combining in and out of class. From the perspective of cultivation subjects of engineering and technology talents, the main elements of education should be re-examined. Based on the talents' career development ability, both Chinese and foreign universities and enterprises should be included in the talent cultivation system. From the perspective of cultivation objectives of engineering and technology talent, attention should be paid to the formation of talents' comprehensive quality and the cultivation of engineering practice ability to cultivate comprehensive and qualified talents who possess new science and technology and interdisciplinary knowledge so as to meet the requirements of engineering field. TNHE should pay more attention to the all-round cooperative education of politics, industry, universities and research institutes, integrate innovation and entrepreneurship education and enterprises' demand for talents into the whole process of talent cultivation, in order to meet the demand for talents in the context of globalisation.

TNHE is an important part of transnational economic and technological cooperation. This paper puts forward an innovative model based on the theories and practices of engineering and technology talent cultivation in TNHE. Firstly, TNEPs in the cultivation of engineering and technology talent in China should be based on the NEE concept and establish a cooperative cultivation mechanism between universities and enterprises. With the increasing number of TNEPs, the model of engineering and technology talent cultivation can be optimised and upgraded. Under the Four-Dimensional Talent Cultivation Model, Chinese and foreign enterprises can be integrated into the cultivation system, therefore, adopting

favourable and effective resources of both universities and enterprises and giving full play to the practical advantages of the enterprises. Secondly, universities should widely set up entrepreneurship incubation bases, science and technology entrepreneurship practice bases and other innovation and entrepreneurship platforms among Chinese and foreign enterprises, and integrate advanced concepts and experience of enterprises for paving the way for in-depth engineering and technology talent cultivation. Thirdly, the curriculum development of engineering and technology talent cultivation in universities should pay attention to the development and changes of the market and the actual needs of enterprises, and optimise the curriculum system based on the analysis of the current situation of enterprises, the development trend of technologies and products in the future. Lastly, universities and enterprises should extensively carry out industry-university-research cooperation in the field of engineering and technology, make full use of the talents' technological advantages of universities and enterprises' business advantages, and combine talent cultivation, scientific research and development, technological innovation and enterprise development to achieve a multi-win situation.

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Regular Paper

INŽINERINIŲ IR TECHNOLOGINIŲ TALENTŲ UGDYMAS TARPTAUTINĖSE AUKŠTOJO MOKSLO INSTITUCIJOSE, PASITELKIANT INOVATYVIUS MODELIUS BEI PRAKTIKĄ

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SANTRAUKA

Tyrimai apie inžinerinių ir technologinių talentų ugdymą tarptautinio aukštojo mokslo (TNHE) kontekste daugiausia telkia dėmesį į tai, kaip pasirinkti švietimo šaltinius, kaip pagerinti švietimo mastą ir kaip padidinti socialinę įtaką. Nėra daug nuodugniai atliktų tyrimų ir praktikos, susijusios su TNHE modeliais, profesine sandara ir talentų ugdymo sistema. Šiame darbe taikomas kokybinis tyrimo metodas ir patirties apibendrinimo metodas, skirtas analizuoti Kinijos inžinerinių ir technologinių talentų ugdymo modelį. Taip pat siūlomas keturmatis talentų ugdymo modelis, atitinkantis Kinijos naujojo inžinerinio išsilavinimo (NEE) reformos tendenciją. Iškeliami gyvybiškai svarbūs įmonių interesai, kurie užtikrina įmonių entuziazmą dalyvauti tarptautiniuose švietimo projektuose (TNEPs). Keturmatis talentų ugdymo modelis ne tik sujungia talentų ugdymą, mokslinius tyrimus ir plėtrą bei technologinių inovacijų ir įmonių plėtrą, bet ir atitinka pagrindinius inžinerinių ir technologinių talentų ugdymo reikalavimus globalizacijos kontekste.

REIKŠMINIAI ŽODŽIAI: NEE, THNE, inžineriniai ir technologiniai talentai, TNEP, talentų ugdymas.