From the Research of Engineering Education to the Construction of Higher Engineering Education

Tian-yi ZHANG¹, Hong-bo SHI²*, and Shi-yu WANG³

¹,²,³Harbin Institute of Technology, Harbin, China

*Corresponding author

Keywords: Higher engineering education, Engineering education research, Engineering education reform.

Abstract. Since the reform and opening up in China, the demand for engineering and engineering talents has become more and more prominent. Research of engineering education in China has been deepening, and the education literature has become increasingly rich. The globalization of world economy has brought China’s higher engineering education to internationalization process, Diversification, the direction of synergies, calling for the construction of higher engineering education. By analyzing and summarizing the relevant periodicals of higher engineering education research in China, this paper combs the research achievements of higher engineering education abroad. On this basis, it defines the historical stage of higher engineering education research in China, and the outstanding achievements in the construction of higher engineering pedagogy. The problem puts forward the corresponding countermeasures, so as to construct the discipline system of higher engineering education at the macro level, and lay a solid foundation for the creation of higher engineering education.

Introduction

Since the reform and opening up, Chinese scholars have made summary and discussion on the research achievements of foreign engineering education and literature of engineering education has led to the development of engineering education research in China, which has also created favorable conditions for engineering education. By analyzing and summarizing Chinese periodical literature, it will be helpful to see the historical evolution process of engineering education in China, clarify the tasks and main problems of engineering education, and seize the opportunity of international trend of education. Reform the status of engineering education to cultivate excellent engineering technology talent in line with international demand.

Evolution of Engineering Education Research in China from the Perspective of Literature

In order to clarify the historical trajectory of higher engineering education research in China, it is necessary to analyze the quantity distribution, author, subject and content of periodicals relevant to “engineering education”. In this paper, we use CNKI database as a reference literature database to analyze the relevant data.

Distribution of Journal Literatures from 1979 to 2014

In the China Academic Journal Network Publishing Database (CAJD) which belongs to CNKI database, we use “engineering education” as a search keyword to do “accurate” retrieve, then we can find out 3990 literatures published before 2014, and first began in 1952. After the statistics analysis, we found an article called Eighty-Year-Old De-san Wang Educated by Yellow River Diversion Project published by New Yellow River No.4 in 1952, the “education” in this title is a verb, and “engineering education” is not a noun phrase. Decade of Exploration Engineering Education Work published in 1959 is the first known engineering education research journal literature. After nearly 20 years of silence, the second engineering education research journal literature appeared in 1977. Table
1 lists the annual distribution of periodicals literature titled with "Engineering Education" from 1979 to 2014. These documents can clearly represent the scale of China’s engineering education research, and its annual distribution can also clearly show the trend of it.

Table 1. The annual distribution of journal literature titled with “Engineering Education” (1979-2014).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature quantity</td>
<td>2</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>27</td>
<td>39</td>
<td>22</td>
<td>50</td>
<td>69</td>
<td>64</td>
<td>99</td>
<td>83</td>
<td>475</td>
</tr>
<tr>
<td>Literature quantity</td>
<td>106</td>
<td>82</td>
<td>50</td>
<td>73</td>
<td>71</td>
<td>123</td>
<td>97</td>
<td>114</td>
<td>114</td>
<td>98</td>
<td>78</td>
<td>71</td>
<td>1077</td>
</tr>
<tr>
<td>Year</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
<td>2006</td>
<td>2007</td>
<td>2008</td>
<td>2009</td>
<td>2010</td>
<td>2011</td>
<td>2012</td>
<td>2013</td>
<td>2014</td>
<td>12 years subtotal</td>
</tr>
<tr>
<td>Literature quantity</td>
<td>94</td>
<td>103</td>
<td>110</td>
<td>139</td>
<td>168</td>
<td>182</td>
<td>209</td>
<td>224</td>
<td>276</td>
<td>278</td>
<td>332</td>
<td>305</td>
<td>2420</td>
</tr>
</tbody>
</table>

Reasons of the Engineering Education Literatures Distribution from 1979 to 2014

Here we take 12 years as one period and make the addition statistics to the data given in table 1. The quantity of literature titled with “Engineering Education” was 475 in the first period (1979-1990), 1077 in the second period (1991-2002), 2420 in the third period (2003-2014), and the quantity of literatures in second period is about 2.26 times the first period, the third period is about 2.24 times the second period, while 5.09 times the first period. From the view of literature periodicals, Higher Engineering Education Research, Chinese Higher Education and China Electric Power Education have published most of relevant articles, Shu-yong Jiang in Harbin Engineering University and Ling ZHOU in East China University of Science and Technology are high yield authors. The results show that the “Engineering Education” literature has undergone a slight fluctuation in the past 36 years, and the quantity of relevant literatures will probably continue to grow rapidly in the future.

China’s engineering education was able to make rapid progress after the reform and opening up in 1978. As can be seen from table 1’s data, the quantity of journals in 1986 was significantly higher than 1985. As before 1985, the focus of the development of education in China was to restore education and teaching order, the implementation of the First Five-Year Plan gave priority to development of heavy industries, it has resulted in an unbalanced status of economic structure and engineering education system in China. Therefore, it has failed to carry out engineering education research and reform in a comprehensive way. Since then, the Central Committee of the Communist Party of China has put forward the “Decision of the Central Committee Communist Party in China”, the reform of engineering education system in China has been carried out formally, and relevant literatures have emerged at that time. From 1985 to 1992, China entered the period of economic system reform and target exploration. Carrying out the reform of state-owned enterprises and further opening wider to the outside world, and the economic system reform goal of establishing a socialist market economic system was established in 1992. It has created favorable conditions for the reform of engineering education system. Therefore, the overall quantity of engineering education literature in this period is large than the other period. But in the international society, the level of education in China is obviously behind the western countries, carrying out reform of educational system is an urgent task, and the expansion of university autonomy has greatly promoted the research of higher engineering education. Engineering education entered a period of quality improvement after 2000, a series of teaching reforms have been carried out on engineering education on this basis. In 2008, the establishment of CDIO Project Education Research and Practice Group has contributed greatly to the enrichment of relevant literature.

The study of engineering education, which is mainly based on higher engineering education, has been gradually deepened, which has laid an important academic foundation for the construction of engineering education and higher engineering education. With the continuous progress of engineering education reform in China, the research on engineering education is becoming more and more active.

Research Topics in Engineering Pedagogy

The subjects of Engineering pedagogy and higher engineering pedagogy are engineering education (activity) and higher engineering education (activity). The research contents of engineering education
and higher engineering education are extension and deepening of engineering education research and higher engineering education research.

Research Topics in the Initial Stage of Higher Engineering Pedagogy

In 1980s, China established a cooperative group for educational research in higher engineering colleges, the theme of this organization work mainly includes the prediction and planning of engineering education personnel training direction; the organization structure, scale, level and school running system of higher engineering education, and the division and layout of engineering education specialty. Operation rules to cultivate all-round development of higher engineering technical personnel work. Training objectives, teaching direction, teaching purpose, education standards, teaching order and plan, knowledge and ability structure, the use of teaching materials, teaching content and methods and so on; The present situation and current problems of higher engineering education abroad. Economic, political, cultural, social background, international evaluation, experience that can be used for reference, it also includes the management of higher engineering colleges.

In 1990s, China established the Higher Engineering Education Research Association, and put forward the Eight Five Project Plan of higher engineering education research. Its main theme has eight aspects: The training of higher engineering talents should strengthen the direction of socialist education; A systematic study of the objectives of higher engineering education; Research on the adaptation of higher engineering education to production activities and scientific research; Further deepen the reform of the educational system and improve the quality of engineering education; The subject of engineering education; The evaluation method of higher engineering education; The construction of higher engineering colleges and universities; The study of the subject construction of higher engineering education. The 8th of these research subjects are about the contents of the subject of higher engineering education, and the teaching materials of higher engineering pedagogy should be written according to its requirements.

Further Research on Higher Engineering Education

Guang-dou Zhang, one of the pioneers of engineering education research, has given a detailed outline of this research and tried to make an overall study on problems such as the significance and components of the modernization project, the power of engineering, the level and model of engineering education structure, the continuing education for engineering talents, the ways of appointing engineers, the national and social support for engineering education, the interaction between engineering and society, the development of engineering profession and so on, to form the report named “Higher Education of Engineering China: Future Technology” and accelerate the development of engineering education in China. The plan, though not implemented, points the way for the future of engineering education research and leaves room for it.

Academician Gao-feng Zhu, Chinese Academy of engineering, former executive vice president of Education Advisory Committee, has closely tracked the development trend of the world information technology. At the same time, he has made useful explorations on the problems about China's engineering education and technological innovation and other aspects, publishing many articles. He published “Present Situation and Prospect of Engineering Education in China” in Higher Engineering Education Research, which summarizes the progress of the engineering education in China in recent years and analyses the problems existing in the practice of engineering education in China form five dimensions: the contradiction of supply and demand, convergence of goals and ways, the lack of experience in engineering practice teaching, the education system does not meet the engineering requirements and students’ quality. Finally he pointed out the serious challenges that China's engineering education faced and the future prospect of its development. After conducting in-depth analysis on our current engineering education, academician Gao-feng Zhu pointed out the development trend of international engineering education, expounded basic concepts and essential
features of engineering education, put forward a goal of combining the frontier exploration and practice experience at home and abroad and establishing higher engineering education subject.

In the article named “The Discuss on Some Understanding Issues About Modern Engineering Education”, former executive vice president of Tsinghua University professor Shou-wen Yu analyzed the new demand in the “big project” of the world and the news changes about the engineering education at home and abroad, put forward the problem about cultivating the diversity of students’ quality, discussed the integration trend between engineering and other disciplines and put forward the goal of the development of engineering education in China and the classified hierarchical propulsion strategy.

Measures to Promote the Establishment and Development of Higher Engineering Education

In a literature named “The feasibility Study of the Establishment of Engineering Education” published in 2011, the author puts forward that China should pay attention to the development of engineering education research field and subject, sort out the development situation of engineering education research in China and demonstrate the feasibility of the establishment of two disciplines of engineering pedagogy.

![Figure 1. Structure of engineering education system.]

The Goal of Engineering Education Meets the Urgent Needs of Industrial Development

The school should have a firm courage of the reform, constantly close to the needs of engineering production, redesign the curriculum system, teaching order and teaching model, aim at cultivating outstanding engineering industry innovators with engineering theory, humanities literacy and entrepreneurial innovation awareness, regard the real project as a foothold, conduct the engineering education reform fundamentally. The school should pay attention to the integrity of engineering education curriculum, see the four years learning of the undergraduate students of as a whole and divide the learning content into three stages: basic education stage, professional strengthening stage and project practice stage. This kind of education and teaching methods can adapt to the cognitive law of students’ learning, and also ensure the continuity and consistency of students’ learning. Moreover, we should see the tasks of students as a whole, including engineering education and innovation and entrepreneurship. The holistic design of the learning content can break the boundaries of the discipline, integrate the different teaching contents organically, arrange the teaching of interdisciplinary content and treat the students’ life and study as the whole arrangement. At the same time, to improve the degree of emphasis on entrepreneurship education. Innovation and entrepreneurship is not just a learning task of students, but also should be a student life in a module, really bring the business into the school. School should use overall theory and operation way to change the traditional engineering education to effectively develop students’ entrepreneurial awareness and entrepreneurial ability.
Integration throughout the Whole Engineering Education

In the curriculum design content, full consideration should be given to the impacts caused by the students’ differences in levels and the ability to accept, the teachers’ teaching ability, the overall strength of institutions and other aspect. In order to promote students, conduct cross-style learning efficiently, avoid the coordination problem caused by the integration of too many modules, on the basis of learning from the advanced experience of engineering education, transfer mobilization of all parties involved, joint research, and well-designed more should be transferred to form a complete modular course design.

Gradually Realize the Practical Guidance of Engineering Education

Practice orientation is not only the basic connotation of engineering education reform, but also the fundamental way to train high level talents, develop entrepreneurial and innovation. It should be regard as a main way to cultivate innovative engineering and technological talents.

From the operation of the project, the development and design of specific projects to the various stages, the research project have responded the guidance of practical guidance.

Besides project learning, higher engineering institutions should give students a variety of ways to participate in the actual operation of the project, emphasizing that the innovative engineering and technological talents make progress in practice, apply the theory to the operation of the project, which reflects the importance that practical operation about the higher engineering institutions and promote the training of entrepreneurial talents.

Acknowledgement

Sponsored by Ministry of Education humanities and social sciences research project special task (15JDGC011), Shandong social sciences planning research project (16CRCJ01), and Harbin Institute of Technology (CGPY-201428).

References


