Building a diversified mode for training talent

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ABSTRACT: Engineering is an important part of modern civilisation, economic operations and social development; and it profoundly affects every aspect of human life. The continuous and meaningful development of engineering is closely related to innovation in all countries, including China. Engineering colleges and universities are an important source of engineering professionals and innovation and, as such, have a particular mission to foster students' innovative qualities, initiative and entrepreneurship. Considering the present situation of engineering major college students in China and their innovative abilities, the authors have analysed various factors that influence the promotion of college students' innovative ability and, on this basis, they put forward a solution addressing different aspects that could build a diversified talent training mode, and facilitate cooperation between colleges and society, businesses and households. This article looks at the training of engineering major students who should have innovative quality and at educational reform in general.

INTRODUCTION

In the rapid development of world science and technology, engineering and technical professionals play an important role in promoting economic development and social progress. College students, well-trained in high-level educational systems, will become the main force of engineering and technical personnel in the future. Their innovative spirit, and engineering and technology innovation abilities will be closely aligned with international competitiveness, and primarily with the process of industrialisation and modernisation in China, and they will carry forward the national goal of building an innovation-oriented country. Therefore, it has become crucial to improve university teaching to develop students' innovative qualities, and combine that with research in this area

Based on the literature, it is evident that scholars and academic teachers in different countries and times have been engaged in the advancement of innovative qualities and concerned about the role that engineers will play in the future. For instance, in the 1950s, the American psychologist Guilford's research focused on the underlying factors of intelligence and intelligence tests, and he promoted the cultivation of innovative and creative thinking [1].

The New Engineer by Beder, a book published in 1998, was designed mainly for engineering students and it focuses on the complex roles that engineers will have to play in the future and the multiple skills and qualities that will be required of them. Beder thinks that most of engineering students will practise their profession in the future, and some will become managers, scientists or business people [2]. She holds the idea that students' innovative qualities must be established as part of their overall development during their studies [2].

At some Chinese universities, it is recognised that students' innovative quality can be defined as an individual use of all known information, including the person's knowledge and experience.

In relation to engineers, this approach helps engineers to produce unique, needed and socially approved products. These studies guide the way to the development of innovative quality in a broad outline; however, the relationship between various factors impacting on creativity and innovation may require further examination, particularly in specific contexts, such as Chinese universities and colleges.

Against the background of characteristics and trends in engineering and technology education, the authors have focused on engineering college students' innovative quality and examined it from various perspectives, including the need to construct a diversified personnel training mode, compliance with government regulations, standardisation, promotion of future engineers and their roles, deepening of the manufacture-learning-research cooperation, and enhancement of cooperation between colleges, universities, enterprises, society and other stakeholders.

THE CURRENT SITUATION OF ENGINEERING MAJOR STUDENTS' INNOVATIVE QUALITY

Lack of Truly Outstanding Students Despite an Overall Large Number of Graduates

There are more than six million Chinese engineering college students, ranking first in the world in terms of numbers. At present, nine out of ten in higher education schools in China have an engineering major, and the number of engineering students has also been ranked first in the total number of students in each engineering speciality. Consistent with the expansion of industrialisation, the number of engineering college students has been increasing dramatically, and this increase is substantially higher than in many other countries.

Although the number of engineering students in China, both university and college, is the highest in the world, but the decline of engineers' social status and reputation year by year has detrimentally impacted on the number of students willing to study engineering. An example illustrating this situation is the comparison between the total number of management science students that maintained a substantial growth in China, with the number of engineering students that grew slowly over the 2009-2010 years and, then, started to decline rapidly, see Figure1.

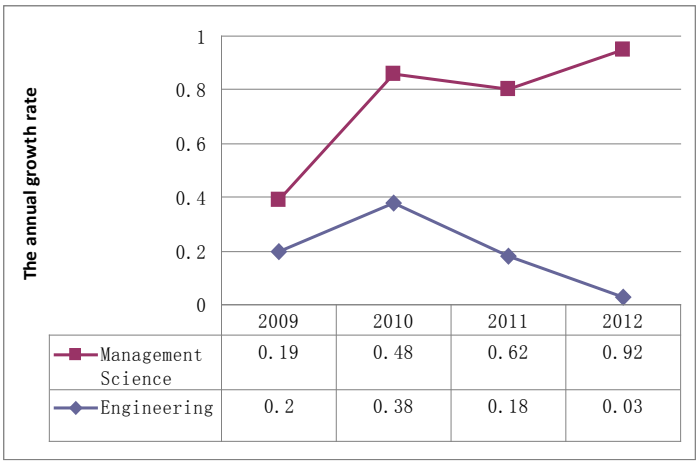

Figure 1: Comparison of the enrolment rate between engineering and management science students.

Figure 1 compares engineering and management science students' enrolments from 2008 to 2012. It demonstrates that increasingly more students chose a major in economics, management, law or computing etc, rather than engineering. They expect to be white-collar workers or even run a business on their own, which will lead to a lack of engineering students and to less talented students undertaking engineering studies. This situation is clearly not compatible with the current needs of industrial development and China's huge demand for engineering talent. The lack of outstanding engineering students impacts on the whole process of educating engineers resulting in an education system that is not conducive to innovation and lacks stamina.

Students' Superficial and Narrow Knowledge

Creative talent must start with solid basic knowledge. Without solid basic theory and knowledge, there can be no innovation [3]. Many scientific workers' outstanding achievements in science and their solid basic theory, as well as skills in scientific research are inseparable. Colleges and universities, especially engineering universities, follow the traditional approach of paying more attention to the major (narrow speciality) rather than the base. Moreover, during the learning process some students focus on quick success, tend to be inconsistent, impetuous and strongly influenced by the utilitarian value of the market economy, resulting in deficiencies in students' basic theoretical knowledge and their lack of solid basic skills.

Nowadays in China, high schools have implemented an earlier division between liberal arts and science students, which results in inadequate cultural exposure, and impacts on the quality of comprehensive training; thus, limiting students in engineering majors to a basic and narrow education. Most students have learned less humanities-related knowledge - most engineering majors students have not read China's *four masterpieces of literature* (i.e. *Water Margin*, *Romance of the Three Kingdoms*, *Journey to the West*, *A Dream of the Red Chamber*, all written during the Ming and Qing Dynasty, and attributed to Shi Nai'an, Luo Guanzhong, Wu Cheng'en, Cao Xueqin, respectively).

Many college students cannot write well - their expressions are a tangle of uncontrolled impressions. It is hard for them to write a program report or an engineering design project. The lack of basic humanities knowledge makes the improvement of their humanistic quality a rather difficult process. In order to develop humanistic quality, students require a proper and consistent exposure to culture, and need to accumulate and absorb systematically over a longer period of time. Some students lack that accumulation of knowledge of the humanities, they have little humanistic spirit, which undoubtedly seriously affects the cultivation and improvement of their innovative thinking and innovative ability.

Poor Engineering Students' Practice and Innovation Ability

During recent visits to enterprises by engineering students, employers have assessed the students' practice and innovation ability as weak, and suggested that their creative quality should be improved. According to a survey involving a range of employers related to industrial, manufacturing, transportation, construction, telecommunications industry, education and research, and other industries, 44% of employers believe that the currently employed engineering graduates lack scientific attitude and spirit (their approach is not rigorous, approach not careful, they do not dare to doubt, are not open to criticism, innovation, etc). 40.2% of employers believe that students' project awareness (such as economic management awareness, ethical awareness and ethical awareness, etc) and innovation awareness are insufficient. 38.0% of employers think that students cannot understand and solve engineering problems very well.

In addition, some employers believe that engineering graduates cannot use technology and modern tools necessary for engineering practice properly. They cannot operate experiments, and analyse and interpret related data skilfully. Besides, there is a considerable percentage of graduates whose independent working ability is poor, oral and written communication is weak, lifelong learning commitment is insufficient and active learning enthusiasm is not high. There is an urgent need to improve engineering students' practice and innovation ability; however, a comprehensive approach to this improvement seems a complex and difficult process.

THE ANALYSIS OF FACTORS THAT COULD INFLUENCE IMPROVEMENT OF ENGINEERING STUDENTS' INNOVATION QUALITY

The One-method Approach to Training Engineering Talent

In the era of economic globalisation, the constant development of modern engineering calls for cultivation of talented graduates capable of project initiation and development, including innovative solutions to solve engineering problems. This cannot be achieved solely with reform of college education [4], because the Chinese engineering talent training mode is very traditional, and does not keep up with new developments and trends. Many colleges and universities are too limited in terms of the teaching content, curriculum design and teaching methods. Existing conventions seriously affect students' enthusiasm, initiative and creativity.

While many colleges have explored and made changes in the teaching content, curriculum and teaching methods, generally, the talent training mode of engineering colleges is still very traditional. This traditional mode is mainly reflected in several areas. First, the teaching content is outdated. Because of the delay in teaching reform, teaching content is far from the latest and does not include crucial developments in modern science and technology. It is not carefully and comprehensively selected and updated from the appropriate sources of knowledge, it lacks the depth and intensity needed for university education, and some science content is simply omitted. The second point is the teaching method. The main teaching methods in many engineering colleges are still based on cramming and indoctrination with little communication between teachers and students. This teaching mode impedes students' independent thinking and innovative ability.

Entrepreneurship and Innovative Education in Colleges and Universities

Innovative education is a relatively new concept in Chinese education. It is a different education system encompassing high quality in all its aspects, focussing on students' attributes and, especially, the need to develop their innovative ability. However, a big gap between China and other countries still exists in terms of innovation and entrepreneurship education, with China's education in need of urgent development and improvement.

There are several reasons for the existing situation in China. First, the teachers lack a sense of innovation. The knowledge that students gain at university during the four years of study is mainly imparted through classes, and teachers as classroom organisers are expected to play a key role in innovative education, but they are not prepared for this role and often do not play it. They are often not involved in relevant research. Thus, the cultivation of creative talent cannot be realised.

Currently, in many institutions, due to high enrolments, teachers' teaching tasks have substantially increased, and many teachers use traditional teaching methods to complete the task, as they do not have proper direction and time to explore new teaching methods or to source appropriate personnel training [5]. Therefore, the key to cultivating innovative talent in engineering majors is to raise teachers' awareness of innovation. Second, students lack passion for study and natural curiosity. They seem to jump to solutions based on mathematical or experimental skill, but do not ask the right questions.

Chinese education often overlooks students' curiosity and imagination, so that many students are simply accustomed to passively answering questions, and lack the kind of initiative that is required to explore issues or problems. Third, universities and colleges lack an innovative educational environment. Some engineering colleges need to improve their hardware and software base, and modernise existing laboratories or set up new ones. They have to discontinue the use of traditional methods and old pedagogical approaches that may hinder the development of creative graduates.

SUGGESTIONS FOR ENHANCING THE INNOVATIVE QUALITY OF ENGINEERING MAJORS

Linking the Characteristics of the Current Era and Building a Variety of Training Modes

Society is continuously developing and changing, and the development of engineering education must adapt to the changing times accordingly. Developed countries' engineering education has focused on the junction between technological trends and socio-economic needs. These countries adjust their training objectives for engineering talent and in timely manner, and strive to cultivate a large number of qualified talents to meet the need of national project construction, and economic and social development.

Engineering education in China should balance the modern engineering characteristics and the country's basic situation. Against the background of economic globalisation and the internationalisation of engineering, academic teachers should approach engineering education from the broad perspective of engineering philosophy and break the traditional training mode. A new training mode has to satisfy the need to develop individual and diverse talent, and to accommodate the specifics of Chinese regional economy and social requirements.

Actively Performing Entrepreneurship Education and Enhancing the Innovative Capability of Engineering Talents

Colleges and universities should pay attention to creating an appropriate atmosphere and environment conducive to the cultivation of creative talent. They should form an incentive system as part of the innovative education, try to change the traditional educational mode, which hinders the development of students' innovative spirit and ability, improve humanistic education, provide clear strategies and objectives, establish an entrepreneurship education curriculum system, introduce entrepreneurship education into the relevant parts of teaching, set up students' entrepreneurship platform, strengthen cooperation with business and enrich student' entrepreneurial activities; thus, providing sufficient innovative talents for the new China. At the same time, it is essential to form an assurance mechanism for innovative education as soon as possible, and formulate relevant policies and regulations to guide the development of innovative education.

An Important Role for Government in Promoting Institutionalisation and Standardisation of Future Engineers Training

A national innovation system not only refers to innovation in general knowledge and technology, but also assumes the innovation of the whole education system, and this is where the government has an important role to play. The high level engineering talent is the backbone of construction and industrialisation. The government plays a leading and security role in engineering education. At present, governments around the world put the development of education, including engineering education at the centre of social and economic development and treat is as a priority.

The Chinese government should actively develop and adjust the relevant higher education policies and regulations according to the needs of modernisation and China's current situation, focusing on basic research in science and engineering, and trying to attract the best talent to lead and educate engineers ready to practise the profession as required by industry.

There is also a need to build a quality assurance system of engineering education, standardise the accreditation process in line with international engineering organisations, to vigorously promote the globalisation and integration of the Chinese engineering education system, so as to create a force of highly innovative practical professionals job-ready and capable of carrying out large-scale construction projects and building an innovation-oriented country.

Deepening the Cooperation with Enterprises, Learning and Research, and Promoting the Alliance of Engineering, Philosophy and Education

Higher engineering education is an important carrier of modern engineering science and technology civilisation. It is a key part of the three-in-one organisation form of education, scientific research and technological innovation. Through the forms and methods of cooperation with enterprises, universities and research institutes have become the focus of national engineering education reform [6].

In recent years, the word c*ooperative* has become a high frequency element in the vocabulary of international engineering education research and practice. China's engineering education must strengthen their alliances with engineering organisations and philosophy groups both at home and abroad, draw lessons from advanced cooperative principles and modes, so as to explore an effective cooperative approach in line with China's large-scale engineering practice and the construction of innovation-oriented country.

Therefore, colleges and universities should not only pay attention to the improvement of engineering quality, ability of innovation, ability of renewing knowledge and the ability of organisation and coordination of would-be engineers, but also apply philosophical critical thinking and ethics to all training, throughout all cooperative education, which would ensure that engineering activities truly serve the goal of sustainable development and the construction of a harmonious society.

CONCLUSIONS

Innovative talent has always been a driving force for a developed and prosperous country. Cultivating engineering and technology talent and fostering innovation are the fundamental goals of colleges and universities all around the world.

In China, there is a need to redesign teaching personnel training and to encourage students to undertake the important task of developing national technology. Colleges and universities have to play an important role in the construction of an innovative country through the provision of highly skilled, creative and ethical engineers.

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