

Teaching and Practice Modes for Internationalization of Excellent Engineers Educations

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Abstract. Today, with the continuous development of market economy and increasing global economic integration, the internationalization of Higher Engineering Education (HEE) becomes the inevitable development trend of the world higher education in the 21st century. Under this context, this paper studies firstly the essentials of internationalization in HEE, then secondly analyses our main barriers for development of internationalization in HEE of China, and finally proposes a self-improving feedback teaching and practice innovation tracking mechanism to improve the capacities of internationalization of chinese HEE.

Keywords: HEE, Internationalization, Education and Training Program of Excellent Engineers.

1. Introduction

In current times, with the continuous development of market economy and increasing global economic integration, the internationalization of Higher Engineering Education (HEE) becomes the inevitable development trend of the world higher education in the 21st century. However, due to the unbalanced development in various countries of political systems, economic levels, scientific and technological potentials, the ideologies and cultures, the problem of internationalization of HEE between different countries becomes complex, and requires more efforts to study in deeper.

Moreover, China is currently in its critical development periods of informatization, industrialization, urbanization, modernization, and globalization, the traditional industrial development modes which rely on high-energy consumption, low value-added and cheap-labour competition are difficult to satisfy the needs of the new era's sustainable development, there is an urgent need to adjust the industrial structures, to transform the economic growth modes, to take a new developing road to industrialization. In order to gain the initiative and dominate roles in future competitions of global economy, culture, science and technology, the talents are the key. Therefore, how can Chinese HEE "for the industry, for the world, for the future" to train a large number of excellent engineers talents to satisfy the needs of our economic and social development, have good knowledge of international rules of the game in engineering and technology, and capable of understanding and communicating with other countries must be considered as a crucial question [1].

Under the above context, this paper tries to take the occasion of "Education and Training Program of Excellent Engineers" (abbr. ETPEE) which is initiated by Chinese Minister of Education in June 2010 and implemented until now by 194 universities and colleges, studying in-deeper the Internationalization of HEE (IHEE) to promote the teaching reform and practice innovation of excellent engineers education.

2. Essential Objectives of Internationalization in HEE

2.1. American and European Countries

American and European countries have implemented many effective policies on international issues. Since the 1980s, on one hand, the needs of academic exchanges, accelerated the development of internationalization, on the other hand due to the increasing needs of economic globalization, promotes the competition and training of talents.

With the integration of European countries in political and economy, the integration of education and even the internationalization has become one of EU primordial goals. In June 1987, the EU launched the Erasmus Program, known as the "European Community Action Scheme for the Mobility of University Students" to encourage students and teachers in the European Inter-Universities the integral activities. In 2004, the European Union supports for the integration, at the same time in order to cope with the challenges

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of globalization, enhance the international competitiveness of European higher education as a whole, launched the "Erasmus Mundus project" which is approved by EU in 2008. Joined the "Mundus" (which means the meaning of "world" in Latin), aimed at strengthening exchanges and cooperation in Europe and other countries in the field of higher education, to accelerate the EU process of internationalization of higher education, improve the international competition forces of the European Higher Education.

As the most advanced higher education country, the United States considers the internationalization of higher education as national strategy to strengthen. In early 1990s, the United States put emphasis on the internationalization of education in Goals 2000 of Educate America Act. It establishes a framework in which to establish world-class academic standards, to measure student progress, and to provide the support that students may need to meet the standards, such as "United States students will be first in the world in mathematics and science achievements", "Every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship". The former President Bill Clinton has made it more clear that the objectives of internationalization of high education for the United States "in order to successfully compete in the global economy and maintain our roles as a world leader", "to ensure that our citizens understanding of the world, master other languages and understand other cultures".

2.2. China

Today, China has become the world's manufacturing centre and in its critical development periods of informatization, industrialization, urbanization, modernization, and globalization. It is obvious that education quality is crucial for modern economy and society prosperity and even survival. Higher engineering education in China was mainly impacted by Europe before 1945, and followed the mode of former Soviet Union in the 20th century, end then influenced by the engineering education of United States after Chinese "reform and opening up" [2]. HEE has went through "engineering process", "Scientific engineering process", and "Return to engineering" since June 2010 with the application of ETPEE in HEE. In May 2010, the State Council examined and approved the national long-term education reform and development plan (2010-2020) which clearly stated that high education should "absorb and learn from advanced international educational theories and educational experience" for the development of our country. As a HEE educators, how should we train a large number of excellent engineers to satisfy the needs of our economic and social development, have good knowledge of international rules of the game in engineering and technology, and capable of understanding and communicating with other countries remain critical.

3. Analysis of Internationalization in HEE of China

In order to answer the above question, we present firstly the Chinese current internationalization development situation, then secondly analyze and outline the barriers (main problems and difficulties) for internationalization, and finally conclude with some remarks.

3.1. Current internationalization Development Situation in HEE

At present, activities involved in internationalization of the university curriculum, importation of foreign educational programs and different levels and kinds of double degrees cooperated with foreign universities have come to play a central role in the internationalization of China's higher education. There are generally four aspects of internationalization of the curriculum in China: introduction of English-language products, especially textbooks, used in the leading universities in the USA (such as MIT, Harvard, etc) into Chinese campuses; implementation of the medium of instruction in the English language or bilingually (Chinese and English) in universities; Integration of an international dimensional program concerning foreign languages/cross-cultural studies into university teaching and learning; and implementation of different levels and kinds of double degrees by sending students to go aboard to benefit completely foreign education systems and cultures at the campus of foreign universities.

In recently years, the last cooperation modes have been made rapid progress. They generally agreed to cooperate with each other in recruiting students, and in mutual recognition of some of their curricula, credits, diplomas, and degrees. Such trans-national education activities continue to take place in countries such as Japan, Korea, and some other Southeast Asian, but also gradually can be found in some Western European countries such as France, Germany, the UK, and Spain.

Another important strategy for our government to promote the internationalization is to establish several huge universities and to support them with enlarged budgets with the aim of becoming world-renowned

universities. This program is called 985 plan, and since 2000, the number of universities funded by the Minister of Education with other government ministries and local authorities has continued to grow (By 2011, up to 39). The goals of 985 plan are to establish world-renowned universities indicating that the internationalization of higher education in China is no longer confined to personal mobility and provision of joint programs in cooperation with foreign partners.

3.2. Barriers of Internationalization in HEE

Although the internationalization in HEE has developed greatly since the reform and opening in 1980s, it remains an important minority of students who have chances to take advantages of international exchanges and opportunities. Our universities and colleges should continue to enlarging its opening to the world, strength theirs international exchanges and collaborations to satisfy the globalization development needs of economy, culture and industry [3]. The main barriers for further development can be analysed as follows:

- The sense of open and collaboration is not strong: especially for the universities which are located in the west or north-west regions.
- The initiatives in international activities are absent. The university leaders, deans, directors of administrative offices and professors should take their active participation in international exchanges and collaborations, and create good international exchange opportunities for students.
- The professors with open mind who are capable of speaking English well, understanding other countries' histories and cultures, communicating and working effectively outside one's own growth environment are limited.
- The paths for internationalization should be enlarged: the active international cooperation in scientific research should be utilized to foster other international activities, ex. exchange of young teachers, double education degrees for undergraduate students, or international key laboratories, etc.
- The integration of employees in internationalization process is not sufficient. The final aim of HEE is to cultivate engineers satisfying the standards of industry.

4. Teaching Reform and Practice Innovation of Excellent Engineers Education

With the analysis of essential objectives and barriers for internationalization in HEE, in this section, we attempt to propose a self-improving feedback teaching and practice innovation tracking mechanism, which is illustrated in Figure 1, to improve the education quality of excellent engineers, capable of adapting to the needs of the economic and social development, having good knowledge of international rules of the game in engineering and technology, capable of creativity and innovations, and understanding and communicating well with other countries' people and cultures. This referred training mechanism which is based on the methods of statistics, computer science and automatic control is composed by the following four parts:

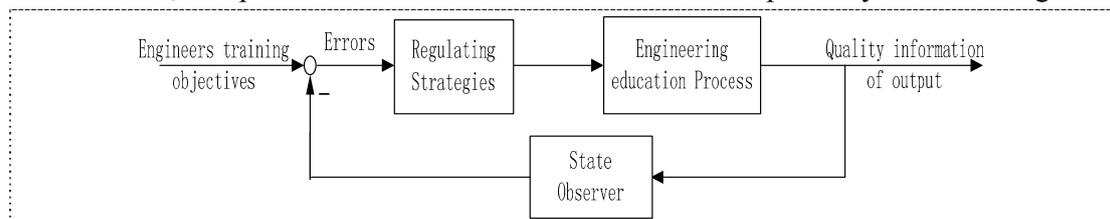


Fig. 1: Self-improving feedback teaching and practice innovation mechanism.

4.1. The establishment of Engineering Training Objectives

The engineering training objectives, which establish the excellent engineers' education standards should be clarified and defined by a Professional Advisory Committee (PAC). This referred PAC is composed particularly by professors, employees and government officers with rich professional practical experiences and solid knowledge in corresponding specialities. By making a clearer definition, objectives via the clarification of the motivations, natures, targets and ways of implementing the internationalization, the PAC should establish the most strict and world-class standards and education program with the supposes that every students could attain and learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our nation's world economy.

4.2. The Engineering Education Process

The referred engineering education process in Figure 1 can be considered as the first registering and last graduating day at institutions. During this process, there are five different parts which includes the students, teachers, universities, employers and government that participating in the engineering education process. Their mutual relationships in details can be referred to [1]. Considering the current graduates with our country higher engineering education, there exists a common phenomena that they lost their humanities morals; lack good faith, professional knowledge, spirit of creativities and innovations; believe in personal interest; and lack the international working abilities. But the goals of higher engineering education are to cultivate students with the global employment competitive power. To ensure successfully the education quality, representative variables that standing for the outputs of the engineering education process should be selected. By referring to [4], kinds of competence can be selected as states of the engineering education process, and some of them which can be measurable directly could be selected as outputs of the process.

4.3. The Informational Database Based State Observer for Students' Competence

The proposed state observer for students' competence is based on a proposed unique informational database which includes the results of academic achievements, the participation in various scientific and technological activities in reflecting the capacities of creativities and innovations, the obtained rewards, demerits and punishments, the records of physical and psychological tests, the placements realized at employees, the abilities of languages skills, and the international experiences and other sub-databases. This referred database is updating with time, and can be used to predict the states of the engineering education process of student status information. With the available states, the corresponding regulating methods and quality ensuring systems, the education results can be explored more objectively.

4.4. The Proposed Regulating Strategies

Now, it is a problem that how to find a suitable way of training engineering talents with international visions, abilities and communication skills by according to the university's trends and social global economy, and this problem is what universities have to face and to solve [3, 5]. The proposed regulating strategies which include the teaching and practice innovation modes are implemented to answer the above question, and to realize the predefined education objectives in 4.1.

4.4.1. Introducing More Faculties with Solid Practical and Rich International Experience

The practice of ETPEE needs plenty of teachers with extensive engineering practical experience which are important for improving quality and rank of engineering education, but unfortunately at present most institutions focus on the teachers scientific projects, academic achievement, and published papers. In recent year, although more and more overseas graduates have returned back, the teachers who are good at comprehensive English skills, understanding well others countries' cultures, having solid background in their special fields and devoting to teaching career with doctorate degree remains limited and should to be encouraged to work at institutions.

4.4.2. Promoting the Conscious and Innovative Sprits Of Students

In order to get to be recruited by well known universities in China such as 985 and 211 national plan universities, the middle school students need to study and work hard on theoretical knowledge, without receiving much practical training during their high school education. When most of them come to universities, they consider that practical training and experiments in universities are not important. What is more serious is that there exists a large number of students have no clear idea about their specialities, no active and innovative sprit to create; To realize the engineering education objectives, one emphasis should be placed on cultivating students engineering practical abilities, such as different types' internships are required: a 1 month internship of worker in their 1st year; a 3 months of professional internship in 2nd year; a internship of project design in 3rd year; and a 4 or 6 months of employee internship in last year. To overcome limited experimental conditions, divers emulation-based virtual laboratories can be build [5].

4.4.3. Innovating the Organizations of International Activities at Universities

At current, the International Exchanges and Collaboration (IEC) activities at universities are arranged at the international exchange and collaboration division whose efficiency is relatively low. There should be a leading group and new division of IEC which will make strategic decisions to integrate various perspectives within university, and implement different international exchange and collaboration activities.

4.4.4. Promoting Students to Build Up Self-Organizing Clubs and Organizations

Our propositions are to encourage students to build up connections via establishments of self-organizing clubs and organizations with international academic and research organizations, such as UNESCO, WTO, IEEE, AMS, SIAM, etc to seek the supports of the funds, scholarships, internships and employment. Through the exchanges and the co-operations, the students can learn the advanced experience and the newest science and raise the level of the abilities of students' international communication, work, and leaderships. Only through the comparison and communication with the others, the students can find the distance with others (ex. USA, UK, France, Germany, etc) to prepare their selves to compete globally.

4.4.5. Selecting the Most Fruitful International Collaboration Modes

Now the international exchange has showed its diversified ways, such as visiting the foreign countries, attending the international conferences, exchange of employees, co-operating of the teaching and science research, introducing the foreign intelligences. A most fruitful and durable collaboration mode could be based on the common research activities which we can use to foster formation of master and doctorate students, exchange of young teachers, and applications of research funds.

5. Conclusions

The internationalization of Higher Engineering Education (HEE) becomes the inevitable development trend of the world higher education in the 21st century. Under this context, this paper studies firstly the essentials of internationalization in HEE in American, European countries and our country, then analyses secondly our main barriers for well development of internationalization in HEE of China, and finally proposes a self-improving feedback teaching and practice innovation tracking mechanism to improve the capacities of internationalization in HEE. With the proposed regulating strategies, the main engineering education objectives which aim to cultivate a large number of excellent engineers talents to adapt to the needs of our economic and social development, have good knowledge of international rules of the game in engineering and technology, be capable of creativity and innovations, and be capable of understanding and communicating with other countries could be realized.

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