

Comparison Analysis of Civil Engineering Undergraduate Curriculum among Universities in China, US and Europe

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Abstracts: University education is a basic stage of engineers' cultivation. The purpose of this paper is to draw instructive conclusions by analyzing differences between Chinese and foreign universities on civil engineering undergraduate education. Teaching methods were taken into consideration. Statistical data in thirty famous universities in China, US and Europe were collected. After comparing differences of civil engineering curriculums from selected colleges, four aspects were analyzed such as the total number of teaching hours, course structure, general education curriculum and practical teaching. It is obvious that specialized courses are taken seriously in Europe universities while general education lessons are valued in American universities. There are also many differences among universities in three regions when referring to approaches of practical teaching.

Introduction

With rapid development of engineering technology and changes in international society, science and technology is the first productive force has been referred to an unprecedented height. University education is the key to handling problems emerging during the rapid expanding development of engineering construction. Changes on modern life and social demand put forward more requirements to professional skills of engineers and technical personnel. The cultivation of professional skills relies more on professional competence that engineers established during a long time. As the most basic quality and ability, professional competence affects working ability of individuals and realization of its social value. On the other hand, it reflects the country's construction potential and national competitiveness in international community indirectly. Therefore, college undergraduate education should be highly regarded.

A large number of civil engineering students graduated from Chinese universities every year. However, China is not excellent in undergraduate education. There are many unsatisfactory factors in the process of education such as excessive theory courses, poor practice ability and lacking of learning initiative of students. ^[1] Thirty leading colleges of civil engineering in China, Europe and United States are sampled. After comparison of statistical data, a basic recognition on similarities and differences among civil engineering education in three regions could be drawn. This paper is aimed at providing information available for the improvement of civil engineering undergraduate education.

Sample selection

Ten top leading colleges of civil engineering were selected in each region. All these samples are leaders in the field of civil engineering education whose teaching achievements are undoubtedly representative. Each university has unique advantages and local conditions. The purpose of this paper is to research their general characters and the universal principles of successful functioning in each university. Some corresponding universities and their abbreviations are shown in Table 1.

Table.1. Selected universities in China, US and Europe

region	abbreviation	overall name	region	abbreviation	overall name
China	TJU	Tongji university	the United States	Purdue	Purdue University
	THU	Tsinghua university		Stanford	Stanford University
	HIT	Harbin Institute of Technology		UTA	University of Texas at Austin
	ZJU	Zhejiang University		UCSD	University of California at San Diego
	DUT	Dalian university of technology		MIT	Massachusetts Institute Of Technology
	CSU	Central South University		UIUC	University of Illinois at Urbana-Champaign
	SEU	Southeast University	Europe	ICL	Imperial College London
	SECUT	Southwest Jiaotong University		Delft	Delft University of Technology
	BJTU	Beijing Jiaotong University		ETH	ETH Zurich
	CQU	Chongqing University		Oxford	Oxford
SCUT	South China University of Technology	EPFL		Ecole Polytechnique Federale de Lausanne	
the United States	UCB	University of California Berkeley	PDM	Politecnico di Milano	
	GIT	Georgia Institute of Technology	NTUA	National Technical University of Athens	

Differences in three areas on teaching

1.The total credits

Among the sampled Chinese universities, Tongji University requires the maximum total credits---197.5 while Southeast University requires the minimum---150. Average credits of all these ten universities are 177.5. Colleges in the United States provide relatively few courses for undergraduates during their college life, except for department of civil engineering in Stanford University, which arranges lessons for 180 credits. Most undergraduates do not take many lessons in class and the average course credits of Georgia Institute of Technology, Purdue University, University of Texas at Austin and University of Illinois are just 128. While in Europe, situation is completely different. Courses are heavy tasks such as National Technical University of Athens which arranges five years education with credits reaching an incredible 246. Credits of Delft University of Technology which is the minimum reach 180. It can be found that European universities regard teaching in class as important when it comes to imparting knowledge of civil engineering professional education. All these statistics data can be found in Fig 1.

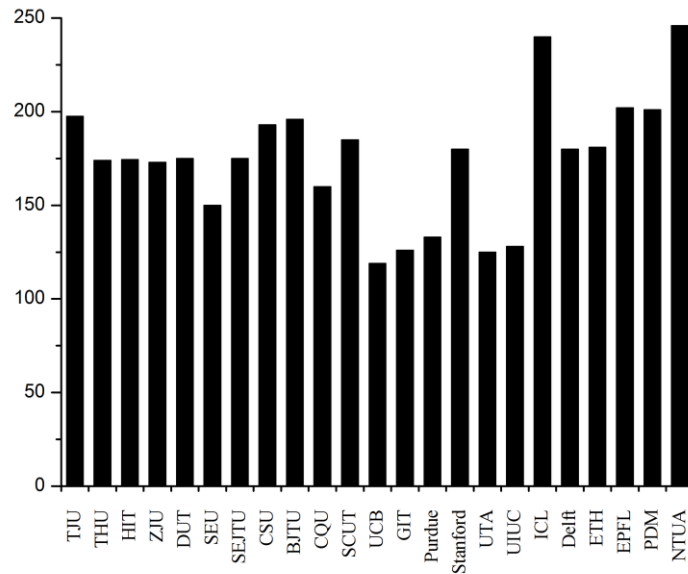


Fig.1 Total credits of sample universities

Apparently, what statistic data in each college reflects is identical with its particular teaching philosophy. Civil engineering education in Europe aimed at professionalism and cultivating applied-talents. So development of professional skills and working ability are highly recommended. This idea shortens the gap between school education and social engineering applications. Thus, graduates are often able to adapt to the transition from students to engineers quickly. Similarly, enterprises would spend less time on training an engineer. In contrast, civil engineering colleges in US emphasize practical ability more, which can be found from the training objectives of some colleges. For instance, education objective of MIT is “Enable students to acquire the ability to recognize, solve civil engineering problems and make decisions considering changes on natural factors and social factors during education”. The aim of Berkeley is “Train engineering technical personnel so that they are laid a solid foundation for their future research and teaching. [2]” The education program in Berkeley requires students to have a good theoretical foundation on mathematics, humanities, economy, communication skills and professional practice.

2.Course Structure Analysis

Curriculum systems in Chinese universities and American as well as European colleges are consistent. It is consist of general education courses, basic courses and core courses. Courses can also be classified into compulsory courses and elective courses. Ratio between credits of courses specified and total credits in some universities can be found in Table 2. Some universities in Europe and US are not included because their courses can't be classified into those 5 categories very precisely.

General education courses credits in Chinese universities occupy 38.4% averagely, the maximum is Beijing JiaoTong University---53%. When comparing eight universities in the United States, the average ratio of general education courses is 45.9% which is generally higher than which in Chinese universities. For instance, credits of general education courses in Stanford University accounts for more than 60%. It is obvious that general education is emphasized in American. A major feature of universities in China is that a large number of credits of English and ideology politics lessons belonging to general education courses are arranged in the first two years. General education courses in the United States do not include English and political lessons. Their courses are more likely to be related to economic and natural science. Thus, comparing with Chinese universities, education in the US is closer to quality-oriented and more beneficial to overall development of students. After reviewing statistical data in European universities, it is easily found that European universities do not given much attention to general education. Ratio between credits on general education lessons and the total credits is generally less than 30%. Basic courses and professional

core courses in European universities attract more attention on general education courses, [3] which is consistent with their education ideas that take the cultivation of professional skills very seriously.

Table 2 Description of Courses

Name abbreviations	Ratio of public elementary courses		Ratio of specialized courses		
	compulsory courses	elective courses	professional basic courses	compulsory courses	elective courses
TJU(China)	39.20%	/	26.10%	15.20%	/
THU(China)	29.30%	12.07%	12.64%	19.54%	5.75%
HIT(China)	19.50%	4%	17.80%	22.30%	4.60%
ZJU(China)	30.90%	7.80%	11%	26%	10.70%
DUT(China)	36.30%	6.30%	14.60%	22%	6.30%
SEU(China)	26.30%	9.70%	20%	19.70%	5.70%
CSU(China)	31.60%	2.10%	25.60%	4%%	15.50%
BJTU(China)	35.70%	17.30%	18.10%	6.90%	7.10%
CQU(China)	40.30%	5%	25.60%	10%	6.20%
UCB(US)	47.10%	5.80%	8.40%	31.10%	5%
GIT(US)	38.10%	14.30%	7.10%	11.90%	26.20%
Purdue(US)	36.10%	16.50%	6.80%	14.30%	22.60%
Stanford (US)	44.40%	17.80%	7.80%	19.40%	22.70%
UTA (US)	24%	21.60%	18.40%	20%	22.80%
ETH(Europe)	28.20%	4.40%	23.20%	36.50%	2.20%
NTUA(Europe)	12.30%	3.60%	17.80%	37.70%	8.50%

3.Comparison of General Education Curriculums

The distribution of general education courses in different universities are shown in Figs.2-5.

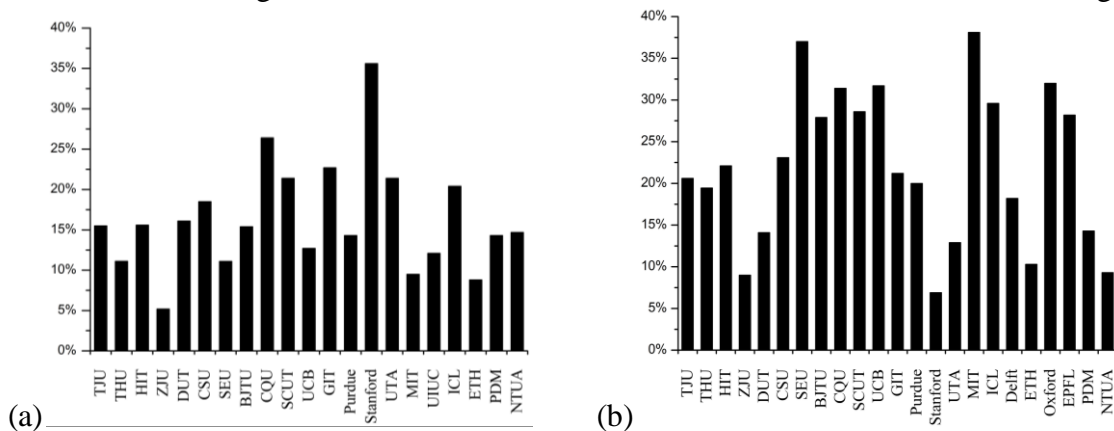


Fig.2 (a) Comparison of General Education Curriculums on art and literature
 (b) Comparison of General Education Curriculums on socialism and science

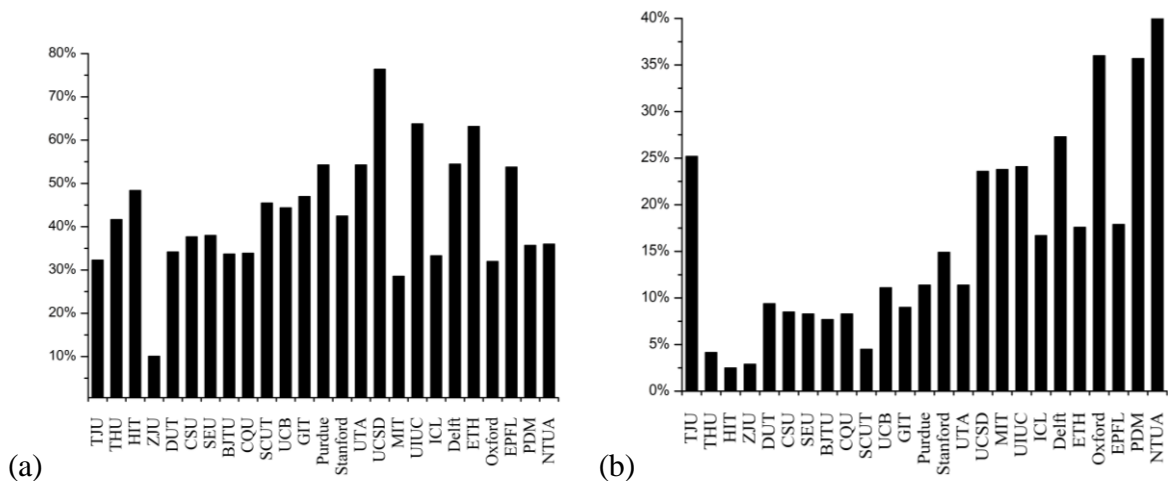


Fig.3 (a) Comparison of General Education Curricula on natural science; (b) Comparison of General Education Curricula on Engineering Technology

General education courses in Chinese universities generally include one or two courses on humanity and social science accounting for about 10%, which is basically the same as European universities. Humanity and social science courses in American colleges range from 3 to 6 and its credits ratio is 18.3% on average. The maximum ratio occurs in Stanford University approaching 35.8%. Reviewing the distribution of general education curricula in each university comprehensively, it is easily found that general education courses in Chinese universities are mainly related to natural science and sociology. The ratio of engineering courses in universities of the US and Europe is slightly larger, especially engineering technology courses. At the fundamental stage of education, foreign universities focus more on basic quality training, which is not the same as Chinese universities. What is more, Chinese universities spend excessive time on political lessons as well as English. Political lessons are abstract while the significance of English lessons is often neglected. Both poor teaching content and ignorance of the substantive role English plays in our future life are responsible for the lack of motivation. Few students in these two classes could have a good interaction with teachers^[4]. As data shows, lessons in Chinese universities on humanity, social sciences and engineering fields are less compared with universities abroad. Both credit limitations and the range of general education courses explain why our students lack in creativity and divergent thoughts.^[5]

4. Practical curriculum

Practical teaching is an important part of higher engineering education. It mainly includes experiment, practice and design three aspects^[6]. It trains students to apply scientific knowledge and methods to solve practical problems. It also trains students' social adaptation ability. It is easily found that practical lessons occupy about 10% among all lessons arranged in four years and practical teaching is emphasized in Chinese universities. In contrast, practical teaching of foreign universities shows no direct relationship with its credits. There are many differences on practical teaching methods between Chinese and foreign colleges. For example, British engineering colleges tend to use 3+1 mode. That is, students study at school in their freshman year, sophomore and senior while they complete engineering practice during junior. Besides completing engineering practice in the third year, students still have to finish their experimental and design curricula^[7]. Although differences of teaching hours of practical curricula between Chinese and foreign universities are not obvious, differences on their teaching process and effects are mainly reflected in the following aspects:

- (1) Practical teaching in Chinese universities is not comprehensive. Curricula are not closely linked to practical knowledge that we actually need later in life.
- (2) During experiments and design, the task-oriented practice is usually completed under the leading of teacher, less students' initiative power is reflected during education.
- (3) Teamwork is usually neglected, which is what we really need.

(4) Insufficient attention is paid on training of social skills.

British and American universities tend to develop a variety of cooperation between universities and enterprises. Universities get fund from the sponsors while students are sent to get trained in enterprises. Enterprise-embedded-mode graduation project is also applied in some colleges. That is, engineer experts are invited to participate in graduation project meeting the current national needs^[8]. A good integration between universities and society is built in this way. Besides, it is easier for students to adapt to social life after graduation.

Fundamental quality

The following qualities are essential to civil engineers adapting to modern social environment.

Engineers should be able to grasp the basic scientific knowledge and have a good knowledge on latest developments in professional field. Besides, they should be skillful at theoretical analysis as well as computer programs. What's more they may have a wide range of general knowledge including sociology and humanity, which enables them to think, plan and organize their researches in higher perspective. Last but not least, innovation and collaboration, communication and organizational skills are necessary^[9].

In order to make achievements in engineering, professionalism at international language, international perspective, solid theoretical foundation, actual technical working ability and project management are indispensable for engineers. Training process in China is strong in theory while lack of practice. Students who have a poor learning foundation on humanities and social sciences as well as liberal arts tend to be weak in innovation, communication and collaboration. Most students prefer studying independently to working with interaction. Fostering professional skills is inseparable from general education in the first two years in college. Only student who have a wide range of knowledge and consider problems from many aspects are able to explore excitement in study and research. Good knowledge and working ability tend to be helpful in students' social life.^[10]

Conclusions

To compare differences between colleges of civil engineering on undergraduate education. Schedules in thirty famous universities in China, US and Europe were collected. After analyzing statistical data collected, four aspects of civil engineering education among universities in china, America and Europe were compared. It's easily found that American universities lay a solid foundation for students and practical ability training is accomplished after graduation. Comparatively, fundamental working ability of students in European and Chinese universities are established during college life. Differences between schools in 3 regions can be concluded as 3 aspects.

(1) General education courses in the United States are more likely to be related to economic and natural science and schools in America emphasize more on practical ability, which can be found from the training objectives of some colleges. While in European universities professional skills and working ability are highly recommended. Basic courses and professional core courses attract more attention than general education courses. Comparatively, European university students take more lessons during their college life.

(2) Comparing with European universities, it is easily found that general education is emphasized in American universities and Chinese universities. However, Chinese undergraduates may spend much time on English and ideology politics lessons in which few students could have a good interaction with teachers. General education lessons in Chinese universities on humanity, social science and engineering fields are less comparing with universities in the US.

(3) Differences on practical teaching hours between Chinese universities and foreign universities are not obvious but foreign schools may lead a comprehensive teaching process. Practical teaching of foreign universities shows no direct relationship with its credits. There are many differences on

practical teaching methods between Chinese and foreign colleges. For example, British and American universities tend to develop a variety of cooperation between universities and enterprises

(4) Teaching methods need to be adjusted to adapt to local conditions whenever necessary. However, it is not wise for Chinese universities to copy foreign models completely. It is better to take local demands into consideration and aim at cultivating highly qualified engineers who is adapt to current construction environment.

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