

The Differences between Undergraduate Education in Civil Engineering in China and America

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Abstract The paper analyzes the differences between undergraduate education in civil engineering in China and America. The purpose of this article is to improve the quality of undergraduate education through referring to each others' advantages based on the findings of the comparison of the teaching plan and the course teaching. The comparison of teaching plan is conducted between four Chinese universities and four American universities. It was found that the rate of general education courses at the American universities was significantly higher than Chinese universities, and their contact hours of lab teaching for the same course are also longer than Chinese universities. The comparison on teaching are conducted between the Wuhan University and the University of Nevada, Reno in the United States by considering the instruction of the "Foundation Engineering" course. It was found that American university pays attention to discussions and learning process, and the American students often ask questions in class. The Chinese university pays attention to the explain of the textbook contents, classroom discipline and test scores. According to the comparison findings, this article suggests that Chinese university should increase the rate of general education courses and introduce student-centered learning mode, discussion sessions, and heuristic teaching methods during classroom teaching.

Keywords: *undergraduate education, curriculum system, classroom teaching, educational philosophy, teaching methods, credit system*

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1. Introduction

The infrastructure, building and construction industry has seen a significant increase since the 1980s in China, which has generated great demands for workers as well as professionals with Civil Engineering skills. Currently, there are more than 540 colleges and universities offering undergraduate education programs for civil engineering in China, which makes China a new higher education giant from the perspective of civil engineering education [1].

However, the traditional education system in China has long been criticized for failing to satisfy the actual needs of the construction sector. New technologies and tactics (such as multimedia and computer-aided learning) also need to be applied to teaching. Thus, the call to reform the traditional education system has been put high on the agenda since 2010 in China, which promotes a series of new projects, including the "Excellent Engineer Education Program" proposed by the Ministry of Education of the People's Republic of China [MEC]. Consequently, these new trends quickly become the hot academic topic in China. For example, the papers [1,2,3] discuss the applications of "Excellent Engineer Education Program" in civil engineering major. The papers [4,5,6] analyze the training model of civil engineering talents, in particular, the establishment of

curriculum systems for application-oriented talents. The papers [7,8] observe the teaching reform in civil engineering undergraduate education, particularly the reform of innovative experimental teaching. The paper [9] compares curriculum systems in civil engineering between Chinese universities and American universities.

Nevertheless, most of these papers focus on their own experiences and lack of international comparative perspective. Considering the world-wide influence of U.S' civil engineering education system, and the importance of the teaching plan and the course teaching in the higher education system, this paper is going to make the comparison of teaching plans and the course teaching of undergraduate civil engineering programs provided by typical Chinese universities and typical American universities. We can draw upon and benefit from each other and make up for each others' deficiencies, especially for Chinese universities to learn from their American counterparts, based on the following comparative findings.

2. The Comparison of Teaching Plans between Selected Chinese Universities and American Universities

Based on the rankings of civil engineering programs, four universities are selected respectively. Among these

four Chinese universities, according to the ranking released by MEC, the first selected is the Tsinghua University [THU] (top 2) because of its high rank in China, then comes the Wuhan University [WHU] (top 21) and the South China University [SCUT] (top 23) with moderate ranks, while the last one is the Guangzhou University [GZHU] (top 30) with lower rank [10]. Because the quality of civil engineering education in the top 10 American universities is far higher than Chinese universities, according to the ranks offered by the US News & World Report 2016, four American universities are chosen with ranks below 10 to strengthen the contrast. The four universities are the University of California, Davis [UCDAVIS] (top 12), the Michigan State University [MSU] (top 43), the University of Nevada, Reno [UNR] (top 43), and the University of Kansas [KU] (top 58) [11].

2.1. The Comparison on the Educational Objectives

The educational objectives of these eight universities are compared in Table 1. It can be seen that the educational objectives of these four Chinese universities are very similar, mainly focusing on the knowledge and skills that the undergraduate students need to acquire. However, both WHU and SCUT further emphasize on “innovative” spirit (instead of critical thinking which is more fond of in American universities), which is clearly the reflection of the Chinese government’s call for “innovation education”. Although there is no major difference between the selected Chinese universities and American universities, the educational objectives of these American universities are more detailed and specific, especially the UCDAVIS and the UNR programs, which is a good example for Chinese universities to learn from.

Table 1. The educational objectives in the different universities [12-19]

University name	The educational objectives
THU	Produce the students who 1) can master the basic theory and basic knowledge of civil engineering disciplines; 2) can undertake the technology and management jobs in building, pathway, bridge and tunnel projects; 3) continue learning and research in civil engineering disciplines; 4) maintain physical health, hard perseverance and strong responsibility to society.
WHU	Produce the students who 1) have comprehensive development of physical and moral quality; 2) learning the basic training for engineers; 3) can work in planning, design, building construction, research, plant operation; 4) have elementary innovative ability.
SCUT	1) Meet the needs of socialist modernization, master the basic theory and basic knowledge of civil engineering disciplines; 2) can solve the engineering problems with professional knowledge and foundations; 3) can undertake design, construction, management, education, investment and development; 4) have innovative spirit.
GZHU	Produce the students who 1) have solid theoretical foundation; 2) can solve the engineering problems with professional knowledge and foundations; 3) communication and cooperation abilities in the team; 4) can be qualified for many kinds of careers, as survey, design, construction, management, education, investment and development, and have the capacity of lifelong learning.
UCDAVIS	Produce civil and environmental engineers who 1) are proficient in the fundamentals of engineering science, analytic and quantitative reasoning, and design; 2) are able to apply these skills in developing safe, sustainable, economical and environmentally sound solutions to civil engineering problems either within the profession or through post-graduate research; 3) grow professionally in their careers through continued development of technical and management skills, achievement of professional licensure, and assumption of roles of responsibility in professional service; 4) understand the needs and represent the diversity of the program's constituencies
UNR	1) Equip students with the problem-solving skills and knowledge necessary for employment in consulting, industry, government, and academia; 2) Produce graduates with the sound backgrounds needed to undertake the analysis and design of civil and environmental infrastructure systems and function effectively in multidisciplinary teams; 3) Provide competent coverage in disciplines so that the graduates can acquire professional registration and those who are well qualified can pursue graduate studies; 4) Graduate well-rounded engineers, who become valuable members of the society-at-large with a good understanding of social, ethical, and technical issues.
MSU	provide opportunities to obtain the knowledge, skills and professional perspective needed for: 1) entry to civil engineering practice and the pursuit of advanced studies; 2) life-long learning; 3) continuing professional development and leadership; 4) licensure; all leading to career success.
KU	To prepare students for professional engineering practice in the analysis, design, construction, and management of civil engineering systems and to prepare them for life-long learning.

2.2. The Comparison of Curriculum System

Both Chinese and American universities have adopted the credit system, the students whose grades and credits meet the degree requirements can apply for the Bachelor’s degree. Most of the colleges and universities will set up several areas of specialization during the later courses under wide civil engineering backgrounds. Table 2 lists several areas of specialization offered by the selected Chinese and American universities. As can be seen, the students in these selected American universities have more specialty areas to choose from than the students in these Chinese universities. Furthermore, both Chinese and American colleges and universities can choose across the areas, there are more courses to choose for American students accordingly.

With regard to the types of courses, Chinese universities’ curriculum usually consists of several types

of courses, such as general basic courses, discipline basic courses, specialized basic courses, specialized courses and practice teaching courses. American colleges and universities generally divided general education courses, lower division courses, and upper division lessons courses.

Table 3 and Table 4 list the credit requirements for general undergraduate programs of these selected eight universities respectively. As can be seen, there is pretty large difference between these universities. For Chinese universities, the contact hours are great in general, up to 2200 or more, and the practice teaching courses, which is listed separately. For the American Universities, the practice teaching credits are included in the upper division credits. They attach importance to general education courses. The lowest general education credits, KU, reached 18.2% of total credits, and the highest, UCDAVIS, credits accounted for 36.4%. The specialized courses appear as the elective courses to make students choose. The rate of general education courses is obviously low for

Chinese universities, less than 10 %. For the same course, Table 4 lists credits and contact hour's regulations for these eight universities. From Table 5, we can find the credits of the same course, American universities are

higher than Chinese universities, the contact hours for the lab teaching is higher too, which shows they pay attention to cultivating students' operational ability.

Table 2. The areas of specialization in civil engineering for eight universities [12,13,14,15,20,21,22,23]

University name	Areas of Specialization
THU	Structural Engineering; Transportation Engineering
WHU	Structural Engineering; Road and Bridge Engineering; Underground Structure Engineering
SCUT	Structural Engineering; Road and Bridge Engineering; Underground Structure Engineering.
GZHU	Structural Engineering; Road and Bridge Engineering; Underground Structure Engineering.
UCDAVIS	Environmental Engineering; Geotechnical Engineering; Structural Engineering and Structural Mechanics; Transportation Planning and Engineering; Water Resources Engineering.
UNR	Earthquake and structural engineering; Environmental engineering; Geotechnical engineering; Pavements/materials engineering; Transportation engineering.
MSU	Environmental Engineering; Geotechnical Engineering; Structural Engineering; Transportation Engineering; Water Resources Engineering.
KU	Transportation Engineering; Structural Engineering; Geotechnical Engineering; Environmental Engineering; Water Resources Engineering.

Table 3. The credits and hours requirements for the Bachelor at the Chinese universities [12,13,14,15]

University name	Credits							Total contact hours (except practice teaching part)
	Total credits	General education course	General basic courses	Disciplines basic courses + specialized basic courses	Specialized courses		Practice teaching courses	
					required	elective		
THU	174	13	59	57		11	34	2240
WHU	150	12	31	66.5-70	15	7-10.5	15	2430
SCUT	183	10	65.5	48.5	10-12.5	10.5-12	36	2292
GZHU	170	16	35.5	29.5	22	34	33	2694

Note: Practice teaching courses include curriculum design, graduate design, surveying practice, geological engineering practice, construction practice, graduate practice and public service.

Table 4. The credits requirements for the Bachelor at the American universities [24,25,26,27]

University name	Total credits	Credits			
		General education courses (university requirements)	Low division courses (college requirements)	Upper division courses(major requirements)	
				Specialized basic courses	Technical electives+ other elective
UCDAVIS	240	87	77	60	16
UNR	129	36	0	75	18
MSU	128	23-24	30	49	18
KU	132	24	36	65	6

Table 5. The comparison on credits and contact hours for the same course [12,13,14,15,24-30]

University name	Soil Mechanics			Fluid Mechanics			Computational Methods in Civil Engineering			Civil Engineering Materials		
	Credits	Contact hours		Credits	Contact hours		Credits	Contact hours		Credits	Contact hours	
		Lec	Lab		Lec	Lab		Lec	Lab		Lec	Lab
THU	3	40	8	3	39	9	3	48	18	2	32	16
WHU	2.5	39	6	2	36	8	2	36	36	2	30	6
SCUT	3	40	8	3	42	6	1.5	16	8	3	38	10
GZHU	2	36	6	1.5	28	4	2	36	18	1.5	30	6
UCDAVIS	4	44	44	4	44	33	4	44	Dso	4	44	44
UNR	3-4	45	60	3	45	Dso	3	30	15	4	60	15
MSU	4	45	60	4	45	45	3	45	30	4	45	45
KU	4	45	60	3	45	Dso	3	45	45	3	45	45

Note: Lec=lecture Dso=discussion.

3. The Comparison on the Course Teaching

The author, Liu, as a visiting scholar, observed the "Foundation Engineering" class at UNR for a whole semester. Through comparison with the teaching at WHU, the differences in classroom teaching between Chinese and American Universities can be explored.

3.1. The Similarities of the Course at Two Universities

3.1.1. The Similarity of Basic Characteristics of Course

The course "Foundation Engineering" is a specialized course for undergraduate civil engineering students in two universities, the basic characteristics of the course are similar, which are shown in Table 6.

Table 6. The educational objective of universities

	University of Nevada, Reno	Wuhan University
Course categories	Elective	Required/Elective*
Credit	3	2
Class hour	39	36
learner	senior	senior

*: Elective by the end of 2012, compulsory after 2012. This is due to the Wuhan University establishing the area of specialty “Underground Structure Engineering” in 2012. The importance of the “Foundation Engineering” course is strengthened, this course is modified by required courses.

3.1.2. The Similarity of Teaching Objective

The teaching objective of the Wuhan University is to make students analyze and solve the problem of the base and foundation of general building by combing basic knowledge about engineering geology with the design theories of structure engineering based on mastering the basic concept and basic principles of soil mechanics [31]. The teaching objective of the University of Nevada, Reno is to make students utilize their knowledge in soil mechanics to perform various types of engineering calculations. This includes consolidation analysis for foundations, and stability analysis of slopes and retaining walls.

3.1.3. The Similarity of the Course at Early Stage

Before you go to study this course “Foundation Engineering” in two universities, you will be required to

study the courses “Soil Mechanics” and “Engineering Mechanics.” Because the course of two universities has many common points, there is a basis and the meaning of the comparison.

3.2. The Differences of the Course between Two Universities

3.2.1. The Differences between the Teaching Contents

The main teaching contents of the foundation engineering class at the two universities are listed in Table 7 for students in the civil engineering major. From this table we can find that the teaching sequences of two universities, broadly are the same, which is first all conventional shallow foundations, next continuous foundations, and finally deep foundations. From Table 7, it is also very easy to find “Fundamental of Soil Mechanics” and “Investigation of Subsurface Exploration” are not included at the Wuhan University, which is because these contents had been taught in other courses. At the Wuhan University, teaching contents include “Special Soil Foundations,” and the focus is on the loess, red clay and expansive soil whose distribution is wide in China, while not included in the University of Nevada, Reno.

Even though they have the same teaching contents, the focus of the teaching contents is different. Table 8 lists the different focus of teaching contents.

Table 7. Teaching contents

University of Nevada, Reno	Wuhan University
Introduction	Introduction
Fundamental of Soil Mechanics	The Shallow Foundations on Natural Base
Investigation of Subsurface Exploration	Continuous Foundations
Bearing Capacity of Shallow Foundations	Pile Foundations and Other Deep Foundations
Estimated Settlement of Shallow Foundations	Retaining Walls
Mat foundations	Special Soil Foundations
Analysis of Pile Groups	

Table 8. The different focus of teaching contents

Main teaching contents	Focus of teaching contents	
	University of Nevada, Reno	Wuhan University
Shall Foundations	Bearing capacity of shallow foundation, stress distribution, immediate settlement, primary and secondary settlement, time rate of consolidation	Principles of shallow foundations design, design steps, the determination of foundation embedment depth, detailing requirements and calculation methods of spread foundations
Continuous Foundations	Type of mat foundations, common types of mat foundations, bearing capacity calculation of mat foundations, compensated foundations	The concept of soil-foundation-superstructure interaction, the model of soil, the design of strip foundations for column
Pile Foundations	Type of piles, the load transfer mechanism of pile, the vertical bearing capacity of single pile, the settlement of pile, correlations for calculating Q_u with SPT and CPT results, frictional resistance in sand, frictional resistance in clay, point bearing capacity of pile resting on rock	Type of piles, the load transfer mechanism of a pile, the vertical bearing capacity of a single pile, efficiency of pile groups, Calculation of the settlement of pile foundations with method of physical deep foundation, the reason and conditions causing negative friction, working character of a pile under lateral loading, the calculation of pile caps, the general steps of pile foundations design.

From Table 8, at the Wuhan University, it could be found that the focus of teaching contents is carrying out the design of the foundations, based on meeting the requirements of bearing capacity and deformation of base [32]. At the University of Nevada, Reno, the focus of the teaching contents and the textbook is calculating the bearing capacity and settlement of the foundations [33]. Many calculation methods and theories are introduced and lots of references are listed in UNR class, but in the Wuhan University class, generally, the teacher just introduces a few classic theories and formulas besides the

recommended methods according to specification and only explains the calculating methods on general working conditions. The depth is far less than at the University of Nevada, Reno. For example, for the calculation of foundation settlement, the teacher usually only teaches in class the largest or total consolidation settlement of foundation center, and for the calculation of immediate settlement and other points’ settlement, they are rarely considered. As for “Stress Distribution,” the instructor only introduces Boussinesq’s approach and Westerggard’s solution, the calculation of bearing capacity of foundation

in the case of inclined and eccentric load are rarely involved.

3.2.2. The differences in the project of the course

Both universities have a big project of the course. The mission of the project is usually arranged before the end of the course at the University of Nevada, Reno, and the project ask a group of three to four people to finish this task in spare time in two weeks. The objective of the project emphasizes that students should be able to use the exploration and soil mechanics knowledge, choose the appropriate theories and calculation methods, and evaluate the bearing capacity and deformation of the foundation. For the structural design of the foundation, it will be conducted in another course in two weeks. While at the Wuhan University, the project of the course generally is arranged after the end of the course. The objective of the project focuses on carrying out the design of the foundation with the method of specification, asking to determine the size and detailing requirements of the foundation and carrying out structure calculation according to the principles of the reinforced concrete structure, and drawing foundation construction blueprints. The students are required to complete the project in a week, and every student should submit a set of calculations and drawings.

3.2.3. The Differences in the Way of Teaching

The differences in the way of teaching exist in many aspects, such as teaching forms in class, homework and examination form, etc.

3.2.3.1. Teaching Forms in Class

All teaching contents are taught by a teacher at two universities, but the difference is at the University of Nevada, Reno, undergraduate and graduate students learn together, while students separately learn at the Wuhan University. Both teachers adopt multimedia teaching method, but the difference is at the University of Nevada, Reno, the teacher sends PPT and related materials to students, and at the Wuhan University, the teacher puts the PPT on the campus internet, freely downloaded by the students. Both contents of PPT are rich with many images, but more flash and animation for the Wuhan University, and more examples for UNR. The textbook is "Foundation Engineering," 3rd Edition, by Mo Haihong at the Wuhan University. At UNR, the textbook is "Principle of Foundation Engineering," 8th Edition, by Braja M. Das. The two textbooks are classic textbooks of both countries. Because "Principle of Foundation Engineering" is written in English and the latest version is published in 2015 with introduction of new technology, it has a wider range of application.

At the Wuhan University, the teacher often asks the students questions during teaching contents in class. Usually the students ask questions after class if they don't understand something in class and homework. At the University of Nevada, Reno, the teacher in class often just briefly introduces main points, and there are not a lot of mathematical deduction, and more is left to the students themselves to read, think and ask questions. If the students don't understand what the teacher said, they can raise questions at once. There are more classroom discussions

at UNR, the teacher attaches great importance to discuss, as the results of classroom discussions are included in the graduate student's grade scheme. The classroom teachings and textbook pay attention to the original source of theories and formulas [33], which will help students understand teaching materials to check formulas and theories, and let the students themselves think. Teaching tactics at UNR is more advanced. Students have clickers which can receive and send the feedback in class. The teacher gets feedback on time to test the students' mastery of class contents.

As far as the classroom atmosphere, it is seriously at the Wuhan University, the teacher will emphasize the class discipline, "Be present on time," "Don't talk and play on the mobile phone," "Don't eat." While, at the University of Nevada, Reno, the classroom atmosphere is more leisurely, students drink coffee and go to the toilet as they like. The teacher and students discuss problems with relaxed postures.

3.2.3.2. Homework and Examination Forms

As far as homework, both universities have a lot of homework. At the Wuhan University, the assignment is mainly the homework behind the chapter material, but at the University of Nevada, Reno, homework is the teacher's own proposition and more comprehensive. At UNR, there are two 30-minute quizzes and one 90-minute midterm examination besides homework, and all are carried out in the class. The teachers will statistically analyze the achievements of the students in the class for every examination, and the achievements will be included in the final grade. The time of the final exam lasts two hours, which is the same for both universities. And the Wuhan University has a special exercise class, accounting for 3-4 class hours.

3.2.3.3. Grading Scheme

About the Grading Scheme, the difference between the two universities is shown in Table 9.

Table 9. Grading Scheme

University of Nevada, Reno		Wuhan University	
Homework	20%	Homework	30%
Quiz	10%	Checking attendance	10%
midterm exam	25%	Exam	60%
Final exam + project	45%		

For students at the Wuhan University, there are attendance requirements. If absences are one-third of total class hours, they will be disqualified from the final exam and there would be no grades for this course. And at UNR, it is not so strict, more than two unexcused absences will result in a drop in the final grade.

To see from Table 9, at the Wuhan University, the final exam is paid much more attention to. The exam is thought to be one method to test the degree of mastering class contents for students, which requests the student to study and review hard before the exam to get good grades. However, at UNR, homework and exams account for more than half of the grading scheme. The final exam plus the project accounts for 45%. This scheme makes it very important for the students to take in account this course

from the beginning, but also avoid the phenomenon that a fail on the final exam couldn't get credit.

4. The Reasons for the Differences in Civil Engineering Undergraduate Education between Two Countries

Through previous comparison, no matter what the curriculum system or classroom teaching of the courses were, there are big differences between the two countries. These differences are mainly caused by the following reasons:

1. The different teaching philosophy caused by the different circumstances: After 30 years of large-scale construction, China is now still investing heavily on public infrastructure projects, including railway, road, and airport construction. Yet the United States already ceased this stage. Thus, The Chinese teaching philosophy for undergraduate civil engineering students is to produce skilled engineers and workers, and hope they can work and fit their jobs immediately. "Excellent Engineering Education Program" and the training mode of application-oriented talents are the exact reflections of this idea [1]-[6]. This idea in teaching shows very obviously in project of the course. From previous comparison of the project of the course "Foundation Engineering," it can be seen that students often just use the theories and formulas provided by the design specifications for calculation without their own ideas, so they only take a week to finish his calculation and blueprint. While in the American universities, such as UNR, for the same project, the students take two weeks to finish his calculation without fixed calculation theories and formulas, they can choose or develop freely the theories and formulas. It is because in American universities, though they also attach importance to practice teaching, but encourage the students' individuality development at the same time. They advocate "modern education mode" which is created by American educator John Dewey in the early 20th century. John Dewey thought the purpose of education should not revolve around the acquisition of a pre-determined set of skills, but rather the realization of one's full potential and the ability to use those skills for the greater good [34]. Martin Luther King (1947), also said: "The function of education is to teach one to think intensively and to think critically. Intelligence plus character - that is the goal of true education [35]." Under this idea, American colleges and universities pay attention to quality training. Because the heart of the problem of a general education is the continuance of the liberal and humane tradition [36], that is the reason for the high rate of general education courses in undergraduate education.
2. China is a country with the largest population. The number of students in the class may be huge, that's why large class teaching is adopted. For example, at WHU, in the courses such as "Soil mechanics" and "Foundation Engineering," the teacher often has to face more than one hundred students. For a large class, the quantity of checking assignments and exams are high, so the teacher rarely arranges the midterm exam. In the U.S., its population is relatively small, about a class of 20 students. For a small class, the quantity of checking assignments and exams are relatively few, so the teacher can take multiple evaluation methods, such as quizzes and midterm-exam.
3. The differences on teaching equipment still exist. Because Most of Chinese universities are supported by the government, and the shortage of funds exists in many universities [37], there are not many advanced teaching equipment in classroom, and the students also do not have the instrument of receiving and sending the feedback.
4. The differences in the classroom teaching for two countries are caused by Chinese traditional exam-oriented education continuing at the university level. Exam-oriented education is one kind of education to cope with the examination, which is a kind of education system with the purpose of further study, the objective of test scores' improvement, and the teaching method of knowledge infusion [38]. Teachers are mostly centralized in class and spend less time for students to ask questions which leads to students absorbing the knowledge passively with less thinking. However, American universities usually advocate "Seven Principles", which are (1) encourages contacts between students and faculty; (2) develops reciprocity and cooperation among students; (3) uses active learning techniques; (4) gives prompt feedback; (5) emphasizes time on task; (6) communicates high expectations; and (7) respects diverse talents and ways of learning [39]. From the previous analysis, the teaching for a course "Foundation Engineering" at UNR has carried out these seven principles well. Secondly, Chinese universities generally adopt this policy "Stringent Entry, Lenient Exit" for the entrance and graduate. In China, there are almost no institutes to find out the rate of graduation below 97% [40]. American universities generally adopt this policy "Lenient Entry, Stringent Exit" for the entrance and graduate. Based on the U.S. Department of Education, National Center for Education Statistics, the 2013 6-year graduation rate for first-time, full-time undergraduate students who began their pursuit of a bachelor's degree at a 4-year degree-granting institution in fall 2007 was 59 % [41]. It can be seen that the graduation rate of American universities is lower than that of China, and it takes a longer time to graduate.
5. Different credit system. American universities execute a flexible credit system. Fully Flexible Credit System (FFCS) is gaining popularity among higher education institutions across different nations slowly. FFCS would mean absolute flexibility for the students in choosing

courses, credits and timing of the courses [42]. The FFCS allows students to graduate ahead of schedule, take temporary absence from the universities or complete their studies in several stages, which is very beneficial for the students whose families are poor, because they can choose to continue their studies after earning money by working. Chinese universities also execute the credit system, but because of the traditional education pattern, it is difficult to achieve the full flexibility. There are fewer selections of students' courses, fixed optional courses every calendar, and students can't arrange courses according to their learning ability. For example, at WHU, the course "Soil Mechanics" is only provided in the fall semester for the junior students, while at all four American universities, this course is offered in spring and fall semester.

6. In China, evaluating quality of teaching is mainly based on the teaching level of teachers and the quality of coursework [43,44]. Schools and departments often appoint a supervisor to listen to the teacher's teaching, check whether teachers present their class on schedule, whether they teach in class according to the syllabus, and evaluate the teaching level of teachers and classroom effect. This system can urge the teacher to make the coursework more beautiful to attract students, ensuring teaching content integrity. In the Wuhan University, there is a lecture competition held every year, the teaching effect and the beauty of coursework will be used as a means of assessment. In the American colleges and universities, teaching contents are arranged by teachers, and there are no specific personnel to supervise. The high or low quality of teaching basically depends on the learning outcome of students and their development [45].

5. The Reference and Improvement on Civil Engineering Undergraduate Teaching in China

Under the current circumstances of China, it would be unrealistic to think that the traditional education system could be fundamentally reformed in a short time. At present stage, Chinese universities can start from their own universities, and draw lessons from the advanced experience of American colleges and universities to improve the quality of the undergraduate education.

1. Continuing to improve the facilities by purchasing or developing more practical and convenient teaching equipment.
2. Speeding up with the pace of international education, introducing "modern education model," increasing the proportion of general courses. Chinese universities need to set up the humanist education idea, introduce advanced foreign textbooks, encourage teachers to visit foreign universities, and learn advanced teaching methods and modes of foreign universities.
3. Improving credit system by increasing students' choice in selecting courses, increasing the

proportion of elective credits. Although some of these measures have already been taken at the School of Civil Engineering, Wuhan University, due to the shortage of the classroom and equipment resources, all the basic courses and specialized courses are wholly arranged by the university, which leaves not too much space for students to arrange their own schedule. Hence, more educational facilities should be provided in order to implement a Fully Flexible Credit System.

4. Encouraging students to participate in scientific research activities and high-level competitions and increasing class hours of innovative lab courses in order to improve the innovative ability of students. In America, many colleges and universities have "Undergraduate Research Opportunities Program." For example, Massachusetts Institute of Technology places the curriculum plan of undergraduates into scientific research. Students who take part in scientific research projects can earn academic credits and become a part of the total credit. In recent years, there are scientific research projects to encourage students to apply for at the Wuhan University. The School of Civil Engineering also organizes students to take part in the national design competition every year. Student attendance of the contest of structure can substitute for internships. The award-winning students have priorities in choosing graduate students' programs. Some other Chinese undergraduates have been qualified to take part in the Mid-Pacific Students Conference competition organized by the American Society of Civil Engineers and make achievements by training innovation ability in recent years. Among them, the students at the Tongji University have got the first chance to national finals competition as the championship of steel bridge team. Both Chinese and American undergraduates feel satisfied in scientific research and competition.
5. Adopting small class teaching, introducing a discussion mechanism in classroom teaching and adopting the heuristic teaching method. Smaller classes lead to higher academic learning progresses, better knowledge of students, and better classroom processes [46]. When talking about the function of the teacher in class, Diesterweg (1835) said "An incompetent teacher forces students to receive knowledge, but a good teacher is teaching students to seek the truth" [47]. So the teacher take all appropriate measures to guide students to actively participate in class. As one kind of incentive means, students' performance in the seminar such as asking and answering questions should become the important basis of grades.

6. Conclusion

The difference between undergraduate education in civil engineering in China and the United States is the

general reflection of the educational philosophy of the two countries.

The objective of Chinese universities for civil engineering students is training professional and technical personnel through professional education. The objective of American universities is training healthy individuals through general education besides professional engineering. Chinese universities should adjust the objectives of civil engineering education and emphasize on the social skills training, instead of only focusing professional and technical contents. Chinese Universities should adopt a Full Flexible Credit System. Regarding the curriculum, the proportion of general education courses must increase. With regard to the classroom teaching, student-centered learning should be introduced and profoundly implemented in Chinese universities while cramming should be discouraged. Moreover, discussion-based teaching and heuristic teaching methods should also be expanded in Chinese universities in order to cultivate students' critical thinking and innovative spirit. On the other hand, American Universities may consider to hold more teaching contest or conferences to promote a more competitive environment and provide more chance of mutual learning among professors.

Acronyms

MEC	Ministry of Education the People's Republic of China
THU	the Tsinghua University
WHU	the Wuhan University
SCUT	the South China University of Technology
GZHU	the Guangzhou University
UCDAVIS	the University of California, Davis
UNR	the University of Nevada, Reno
MSU	the Michigan State University
KU	the University of Kansas
FFCS	Fully Flexible Credit System

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