AC 2007-2361: ENGINEERING FIELD EXPERIENCE ? AN INTERNATIONAL AND CULTURAL PERSPECTIVE FOR CIVIL ENGINEERING STUDENTS

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Engineering Field Experience-An International and Cultural Perspective for Civil Engineering Students

Abstract

Field experiences have been included as class activities in many engineering curricula. Students gain an understanding and appreciation from "real world" applications of topics and theories learned in the classroom. In the past, most of these field experiences have been limited to specific courses and conducted for just a few hours within easy travel distance from a university. The Department of Civil Engineering at North Dakota State University developed a field experience course that takes students to China to gain first hand knowledge on civil engineering design and construction practice, to learn the history of civil engineering and cultural influences on engineering practice, and to have an education/cultural exchange with Chinese students. In collaboration with the Beijing Institute of Civil Engineering and Architecture (BICEA), twelve senior level students and two faculty members visited China in spring 2005. The class visited Beijing, the Three Gorges area of Yangtze River, and Shanghai to observe and inspect specific sites and projects, including the Three Gorges Dam and 2008 Beijing Olympic Games main stadium construction sites, as they relate to the civil engineering and construction education. In Beijing, the class stayed on the campus of BICEA. In addition to campus visit, a mini-conference was organized for American and Chinese students to present their curricula and extra-curricula activities, their campus life, and to have small group discussion. In addition, students were exposed to the cultural and historical implications of engineering education, project planning and design, as well as construction decisions and methods. A course evaluation of the course showed that students have gained better understanding of global perspectives of civil engineering and culture influence on engineering designs, learned what they could never learn in regular classes through site visits and meeting with Chinese students, and enjoyed opportunity for providing input to the design of course components. The course appears to be a resounding success and could offer great benefit to the student's engineering education and future professional career.

Introduction

Graduating engineering students are increasingly being exposed to employment opportunities that require them to work on international projects or spend extended time periods working in other countries. Industrial advisors often stress the importance of international experience, awareness of global issues, and cultural diversity awareness as desirable traits of new-hire engineers. ABET 2000 also lists having "the broad education necessary to understand the impact of engineering solutions in a global and societal context" as an engineering program criterion[1]. In order to prepare students for competing in the global job market, engineering curricula need to address global perspectives and the cultural, economic, and societal impacts on engineering designs[2, 3, 4]. To understand and appreciate different engineering practices, students also should compare their engineering education with the education systems in other countries. Numbers of study abroad and international exchange programs have been developed and carried out at different universities[5, 6, 7, 8].

Based on the interests and demands of students, an international field experience course, CE 796 Field Experience - The Three Gorges Dam and other Civil Engineering Sites in China, was offered to senior civil engineering and construction engineering students at North Dakota State University. The course was developed in collaboration with the Beijing Institute of Civil Engineering and Architecture (BICEA) and with significant inputs from students to focus on the following areas:

1. Studying the history of civil engineering and urban development through site visits;
2. Observing current Chinese civil engineering and construction practices and comparing them with the methods used in USA;
3. Observing ancient engineering and construction practices and comparing them with modern methods and technologies;
4. Experiencing various modes of transportation and mass transportation methods and evaluate their pros and cons;
5. Gaining an understanding of the environmental and socioeconomic impacts of major international engineering projects first hand through site visits;
6. Discussing cultural differences and their impact on civil engineering practices; and
7. Participating in cultural and intellectual exchange activities with Chinese students in Beijing.

This 3-credit course was implemented with regular pre- and post-field trip meetings and 12 days travel to China. Unique aspects of this course include:

1) Involvement of students in the course development;
2) Extensive interaction with faculty and students in China;
3) Direct observation of the impact of engineering and construction projects on people and society;
4) Involvement of students in post-course activities; and
5) Use of the NDSU's Group Decision Center (GDC) for anonymous course assessment and evaluation in an interactive real-time environment.

Course Development and Preparation

The course was developed from a recognized need to better prepare undergraduate civil engineering and construction students for the global workplace. Students enrolled in the NDSU civil engineering and construction curriculum course, *Impact of Technology on Society*, were introduced to civil engineering projects in other countries, specifically the Three Gorges Dam in China. Through a collaboration of Department of Civil Engineering and Construction faculty and students, an international engineering and construction field experience course was created and subsequently approved by the university.

Given the student interest in the Three Gorges Dam project and a Chinese faculty member in the department, it was decided to visit China for the first course offering. Course components included pre-trip activities, a 12 day trip to China, and post-trip activities. The travel schedule

and in-country activities were developed during the once-a-week pre-trip class meetings with contributions from the students and the NDSU international programs office.

The instructor prepared a course syllabus describing the academic requirements, outcomes, and assessment. An outline of pre-trip activities was prepared by the instructor and formalized with input from the students. Student groups assumed responsibility for some aspects of the course including coordination of student international travel preparation, budgeting, researching possible in-country activities, and creating student presentations to be given at BICEA.

Cultural Preparation

Students were tasked with researching the history, culture, geography, and demographics, of China. The instructor arranged in-class presentations by NDSU Chinese students from different provinces and universities who made presentations about their cultural background and university experiences in China. The associate director of the NDSU international programs office, who had eight (8) years of experience studying and working in China, made a presentation to the class. In-class lectures on Chinese history, major historical and modern engineering monuments in China, and basics on Chinese language and customs were presented.

Academic Preparation

The instructor worked with the students to identify interesting sites to visit that would provide appropriate civil and construction engineering student experiences. Students were assigned to learn about the history, societal impacts, economics, and engineering technology of the Three Gorges Dam project, the Great Wall, and the Forbidden City. In addition, there were in-class discussions about the rapidly growing economy, its impact on society, the level of construction, and technological development.

Exchange Preparation

Students were divided into groups to prepare their presentations to be given at BICEA. Presentation topics included a general introduction of the United States and NDSU civil engineering programs; steel bridge design competition, concrete canoe design competition, environmental engineering design competition, ITE student chapter, and construction engineering. The instructor acted as an advisor to the students and provided guidance in preparing their presentations. The students practiced by giving their presentations in class.

Course Activities

The course brought the students to China during the Spring Break of 2005. The group of 12 students and 2 instructors visited Beijing, Yangtze River from Chongqing to Yichang, the Three Gorges Dam, and Shanghai. During the trip, the group participated in various academic activities and visited many sites with a focus of broadening students' engineering knowledge in terms of global perspectives and cultural and economic impacts.

Academic and Cultural Exchange in Beijing

The professors at BICEA arranged transportation, lodging and academic activities for the group in Beijing. We stayed in the guesthouse on the BICEA campus, which is located near the center of Beijing. We had breakfast meals in the student cafeteria everyday. These arrangements provided students with maximum exposure to campus life in a short period of time. Three BICEA students accompanied the student group in Beijing to help with logistical and tour assistance.

The course instructor led a class tour through a few of the BICEA campus buildings observing in-class activities through windows from outside the classrooms. The students visited a campus store and made purchases.

Figure 1. NDSU and BICEA students listening to student presentation from both sides (left). Small group discussions after presentations.

An afternoon mini-conference was organized by BICEA where alternating presentations were made by Chinese and US student which were followed by small group discussions. The NDSU group included members of the American Society of Civil Engineers (ASCE), American Water Works Associate and Water Environmental Federation (AWWA/WEF), Institute of Transportation Engineers (ITE), and Association of General Contractors (AGC) student organizations.

Tour in Chinese Cities and of Historical Sites

The student group visited several historical sites including the Great Wall, Ming Tombs, Forbidden City, Summer Palace, old town of Beijing, and the old city of Shanghai. While at the sites, civil and construction engineering aspects were discussed and observed in relation to their cultural influences.

Figure 2. Two BICEA students and an NDSU student at the Great Wall (left). One of the several new bridges the group visited in Shanghai (right).

Beijing city development is resulting in a shift from residential sprawl to high-rise residential structures; street and highway improvements to accommodate increase in automobiles; intermodal transportation conflicts between pedestrians, bicycles, motorcycles, cars, buses, trucks; and international private sector investment.

Shanghai city development involves a transition from the old city where European influence of the earlier 20th century dominated, to a new city east of the Huangpu River that is greatly influenced by international private sector investment.

Several modes of transportation were observed and experienced by the student group, from riding in a human powered jinrikisha to a magnetically levitated high-speed train. Transportation included school buses provided by BICEA, city buses, jinrikisha, subways, tour buses, commercial jets, river tour boat, human powered "peapod" river boats, and a Maglev train. Students were able to observe and experience the impact of a rapidly developing urban transportation system on the local population and infrastructure in the context of civil and construction engineering technology. Intermodal conflicts between pedestrians, bicycles, motorbikes, automobiles, buses, and trucks was most evident as urban areas transition from predominately foot and bicycle traffic to vehicular traffic.

Construction Site of 2008 Beijing Olympic Games Main Stadium

The class visited the construction site of the 2008 Beijing Olympic Games main stadium, the Beijing National Stadium (Birds Nest). One of the chief engineers of the project explained the design of the stadium, construction schedules and plans. Students observed activities of building the foundation of the stadium.

The stadium is 330 meter long by 220 meters wide, and is 69.2 meters tall. Students learned that the 250,000 square meters (gross floor area) stadium with sitting capacity of 100,000 is to be built with 85,000 tons of steel and most of it is being used only for aesthetic purposes. The stadium was expected to cost up to 3.5 billion Yuans (423 million USD).

Figure 3. One of the chief engineers at the site explains to the group the design of the Olympic Stadium (left). Students observed foundation work at the site (right).

The Three Gorges Dam

One of the main purpose of the trip was to visit the Three Gorges Dam and upstream areas that were affected by the construction of the dam. The Three Gorges Dam will be the largest hydropower station, dam, shiplock and shiplift system in the world, with a 1.2 mile stretch of concrete creating a 370 mile-long 525 feet deep reservoir with a five-step shiplock for navigation.

Figure 4. Old town of Fengdu would be completely submerged under water and was going through demolition, and a new city was built across the river on a high ground (left). The study group at the Three Gorges Dam (right).

The project's main benefits are to reduce the loss of human life caused by periodic river flooding and improve the health of people living close to the river. In addition, there would be reduced flood damage to populated areas. Power generation would help to improve the economy and standard of living in rural areas. There would be less dependence on coal thereby reducing acid rain and greenhouse gases. River level control provided by the dam would also improve and provide safer river navigation. From an environmental perspective there would be reduced

saltwater intrusion into estuaries during periods of low flows and improved water quality in the middle reaches of the impacted rivers.

Social costs of resettlement and environmental damage are enormous. Environmental sustainability of the project in relation to massive resettlement and ecological damage is to be focused in this paper. Chinese officials estimate that the reservoir will partially or completely inundate 2 cities, 11 counties, 140 towns, 326 townships, and 1351 villages. About 23,800 hectares, of land will be impacted causing more than 1.1 million people to be resettled, and accounting for about one third of the project's cost. Many critics believe resettlement would fail and create reservoir refugees. The forced migration would raise social unrest. Many of the residents to be resettled are peasants. They would be forced to move from fertile farmland to much less desirable areas.

There will be a loss of culturally significant areas, monuments, symbols, archeological sites, and other structures important to the nation's heritage. Many scenic areas will be lost from view.

Environmentally there will be a loss of natural plant and animal habitat and species. There may also be an increase of pollution in middle reaches near population centers until adequate wastewater treatment systems can be built in compliance with national environmental laws.

The project has already been the subject of great international scrutiny. It is being called the largest construction project in China since the Great Wall.

Post-Trip Activities:

As part of the course requirements, the students were involved in post-trip activities during the last six weeks of the course. In-class activities included an open discussion among the students of their experiences, preparation of reports, discussion of course assessment and evaluation, organizing on-campus presentations, and coordinating a banquet and presentation for their parents. Presentations were given at a campus wide seminar series – The World I View, to student organizations, to other classes, and to student parents.

Assessment and Evaluation

A digital discussion at the Group Decision Center (GDC) of the university was utilized for course assessment and evaluation. An initial set of evaluation measures in the form of questions were developed by the course faculty and students. The evaluation measures were sent to the GDC to be entered into the system prior to the digital discussion. Using this computer based system for the course evaluation allows questions and answers to be offered anonymously during the discussion. The results are recorded for future statistical analysis and feedback.

Overall, students are very satisfied with the course and field trip. Many of them said they would like to see the course offered in the coming years and would recommend it to other students. One student wrote "This is something that needs to be experienced by everybody; it is something that no amount of reading or watching video can replace." When the students were asked to

provide specific comments on the course quality, they were both complimentary and critical. Major strengths, weakness and suggestions from the students are listed below

Strengths of the course:

1. Gain first hand experience on how different cultures worked.
2. Made the learning experience more interactive.
3. Better to see it for yourself than through a textbook.
4. We got to meet and become friends with a few great people (Chinese students) in China.
5. Really enjoyed interacting with the students from China.
6. It was a class that we were able to put in our own input on and saw direct results. Having direct input on a class is good feeling.

Weaknesses of the course

1. That it is very hard to prepare for a course like this.
2. We should have had a little more in depth language lessons.
3. Some language and cultural preparation would have been nice.
4. A few things could have been cleared up a little more, such as specifics for the trip.
5. The importance of the exchange between schools was not really stressed or not stressed enough.
6. Even though videos don't do it justice, it might be nice to see some before we left.

Suggestions

1. More input from every student before we leave about what they really want to get out the trip.
2. Have students do more research about the cultural sites that they would see to help understand the importance of each site.
3. More interaction with the college in Beijing. Spend some time in a class with them (Chinese students) to see how the teaching and learning methods differ from ours.
4. Work more with the Chinese students at NDSU to get a understanding of how we needed to talk and present ourselves so that the students in China could understand us better.

All the students agreed that the academic exchange activities with the BICEA students went better than expected and hoped that they had been better prepared. Students gained knowledge on civil engineering programs in China through the presentations of Chinese students. They enjoyed presenting their college life and their academic achievement to the Chinese students and faculty, but felt that some of their message was lost because of language barriers. They especially enjoyed interacting with the Chinese students after the presentations. They thought that having Chinese students accompanying the group during site visits in Beijing was one of the best experiences of the trip. One student commented “I feel that I learned 10 times more by having Frank (a BICEA student) around and talking with him the few days he was with us.”

Site visits in China touched on several civil engineering specialty areas including; structures, transportation, water resources, environmental, and construction. Students were encouraged to

make connections to what they saw and heard during the site visits to what they learned in their NDSU civil engineering classes and their experiences in the U.S.A.

In addition to seeing the construction of the Three Gorges Dam and the Olympic Stadium, the group also visited several sites of new buildings and bridges in Beijing, Shanghai and along the Yangtze River. Students were amazed to see different styles of architecture and the speed at which they were built in China. They learned that most high rise buildings were reinforced concrete structures and very few of them were steel structures. Students, especially the members of the steel design team, were very interested in seeing a great variety of different bridge designs and the cultural influence on some of the bridge designs, including architectural style, length, and color. Students also pointed out that some of the structures appeared very costly or even wasteful just to achieve certain architectural effects. For example, they were surprised to learn that steel frames of the Olympic Stadium, called the Birds Nest, were mostly for esthetic purposes.

Since most of the students were from small towns of North Dakota, Minnesota and South Dakota, they found travel and learning how different transportation systems worked in China to be very rewarding. They experienced firsthand public transit in Beijing and Shanghai ranging from city buses, subways, to the Maglev train, which traveled at a top speed of 270 miles per hour. Students also learned that China is building its highway system similar to the interstate highways in U.S. Students commented that paving technology used in China appeared far behind, road quality was not as good, and there was poor road maintenance especially in rural areas.

Summary of Course Outcomes

This course was originally initiated from the interest of students and was designed to address international education, cultural diversity, current issues relevant to civil engineering training and career. Although study abroad programs are common in some of the education programs in the U.S., it was the first time such a course was offered to NDSU civil engineering students. The International Engineering Field Experience course received very favorable reviews by the department and ABET as a positive effort to address international perspectives in the curriculum.

Student involvement in the development of course components instilled a high level of motivation and incentive which contributed to maximum involvement by all the participants and the success of the course. Student feedback resulting from the course evaluation process helped to redesign and improve the course focus and activities for the future.

Partnership with the Beijing Institute of Civil Engineering and Architecture played a key role in achieving the educational objectives of the course. Having a local connection made it easy for arranging visits to the key sites that we were interested in, such as the Olympic Stadium, and having engineers at the site to explain designs and construction to the students. Exchange activities between Beijing and NDSU students were one of the highlights of the trip to China and represented a significant academic and cultural aspect of the course.

First hand observations of the impact of engineering designs and projects on society and cultural influences enhanced student learning resulting in a better understanding of these relationships.

Recommendations

As with many other undergraduate university programs, civil engineering curriculum should include some form of international field experience. Students offered an opportunity to participate in an international field experience will benefit greatly from this type of real-world exposure. While the NDSU course may not be a perfect model for all institutions, it can serve as a starting point and can be easily modified to serve the needs of each institution.

Based on the results of NDSU's first experience, our course is already being fined tuned for the future. Due to the positive results of this first offering, the course is being repeated during the Spring 2007 semester and will include students from the Industrial and Mechanical Engineering Departments.

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