AC 2012-4967: MOVING TOWARDS GLOBAL COMPETENCY FOR ENGINEERING STUDENTS THROUGH TRAVEL AND CLASSROOM LECTURES

Dr. Nick M. Safai, Salt Lake Community College

Nick Safai is the Chair of Engineering Department (which consists of nine engineering programs Civil, Mechanical, Electrical, Chemical, Material Science, Environmental, Manufacturing, Bioengineering. and Computer Engineering). He is tenured Full Professor. He received from Princeton University his Ph.D. in engineering (multidisciplinary), also from Princeton University: M.S. in aerospace, M.S. in mechanical, M.S.E. in civil engineering, and M.S.E. in reservoir engineering/water resources, as well as a B.S. in mechanical engineering from Michigan State. Prior to joining the academics, Safai worked in industry, where he served as Director of the Reservoir Engineering Division at Chevron Oil Corporation in California. He has taught both at the graduate and undergraduate levels in engineering science. He has performed research projects for the Department of Energy (DOE), Department of Defense (DOD), National Science Foundation (NSF), and the oil industry. He has authored more 85 technical publications in technical journals, government and industry project reports, DOE, DOD, and NSF. Safai's research areas of interest have been coupling of solid mechanics and fluid flow, 3-D multiphase flow in an unsaturated/saturated deforming porous medium, wave propagation and stress concentration, and filamentary composite materials. Safai is a member of several international and national Professional Engineering Organizations such as American Society for Engineering Education (ASEE), American Society of Mechanical Engineers (ASME), and American Society of Civil Engineers (ASCE). He has served in various capacities in these societies. He has served as Chair for ASEE Annual Conference Programs for the International Division, a Session Chair, Reviewer, and as the Division's Vice Chair since 1991. Safai is responsible for bringing to SLCC engineering professional societies (ASME in 1992, ASCE in 2001, and ASEE in 1991). Safai is the ASCE chapter president for SLCC. He has organized several other national and international student societies and activities. Christopher Thompson is presently attending Salt Lake Community College, majoring in civil engineering. Thompson is the Student President of the American Society of Civil Engineers (ASCE) chapter at Salt Lake Community College working closely with Safai (the ASCE chapter Advisor) on several engineering and service learning projects. Thompson has been the recipient of several awards and scholarships, including the NCSAS from NASA, which was awarded to him in Aug. 2011. His student president leadership in ASCE has brought several awards to the ASCE chapter at Salt Lake Community College.

Mr. Christopher F. Thompson S.M.ASCE, Salt Lake Community College

Christopher F. Thompson been a student at Salt Lake Community College, in Salt Lake City, Utah, since the Fall of 2009. His current course of study encompasses a dual major: chemical engineering and civil/environmental engineering. While attending SLCC, he has put forth his best effort to become involved in extracurricular activities. He isthe Student President for the American Society of Civil Engineers student chapter at SLCC, as well as the Recording Secretary for Phi Theta Kappa. He looks forward to graduating with an A.S. of general studies in the Spring of 2012 followed by an A.P.E. (associate's of pre-engineering) of chemical/civil/environmental engineering in the fall of 2013. He has chosen civil/ environmental engineering as his academic program and field of study, as a way to grow within my already existing career field. For the past six years, he has worked in the civil engineering profession as a Designer/Draftsman. He has worked closely with civil, environmental, and structural engineers on a daily basis; for him, becoming a Civil Engineer was his next logical career progression. Over the past few years, he has come to realize that he is limiting his potential by remaining a simple Draftsman. He has slowly, over time, developed his mind to work in a critical thinking environment, much like a Civil Engineer must do every day. He has become familiar with civil engineering, and engineering in general, nomenclature. He brings to the table a fresh mind and eagerness to succeed. He truly believes that he has an advantage over similar civil engineering students that are in his same educational position. In today's society, it is his opinion that experience can overrule education. He has every intention to reach a point where my education will meet his experience, creating a complete and well-rounded Professional Engineer. In addition to civil/environmental engineering, he listed his educational minor as chemical engineering. At Salt Lake Community College, these two engineering majors share very similar program requirements during the first two years of study. He has elected to achieve a double major in order to optimize his educational experience. Chemical engineering is a field of study that, when coupled

with civil/environmental engineering, leads into his ultimate goal of becoming a doctor of philosophy in nuclear engineering. civil/environmental engineering will show him how to design and construct an appropriate nuclear facility, while chemical engineering will help him understand the actual nuclear science process.

Moving Towards Global Competency for Engineering Students Through Travel and Classroom Lectures

Abstract

This paper will cover the ideas and concepts presented to first year civil engineering students through classroom lecture combined with onsite international field study. This paper will allow a case study to be presented that will outline the basis for increasing global awareness of first year civil engineering students by exposing them to more than just simple classroom instruction and textbook reading. In order to create a well-rounded civil engineer, educators and academic institutions will have a need to tie together classroom lecture and global competency through international field study, creating a viable global civil engineering student model.

For example, Salt Lake Community College in Salt Lake City, Utah, avidly supports a classroom culture that contains international implications as demonstrated by the acceptance of society level engineering organizations. By combining engineering lecture topics such as The Hoover Dam, nuclear science, and The Colorado River Bridge with actual onsite field study, a distinct connection will be made between the technical subject and reality.

Salt lake Community College students have educational requirements to be completed as dictated by their Engineering Department. During engineering courses such as *"Special Topics in Engineering"* and *"Civil Engineering Design,"* each student is exposed to an endless number of engineering subjects. Each student will then be presented with the possibility to field visit a few select specific topics discussed during these required classroom lectures.

Civil Engineering Students have already had the opportunity to visit The Hoover Dam and The Colorado River Bridge. Salt lake Community College Civil Engineering students have visited and received a personalized tour of a TRIGA Nuclear Reactor present on the University of Utah campus. The growth and future outlook of international field study is increased with the possibility of visiting a global engineering sites such as the Panama Canal.

Allowing students to validate their educational experience with the combination of classroom lecture and onsite international field study will produce a civil engineering student who will not only increase their global competency and awareness, but they will foster passion for their future professional career.

Overview

The success of Civil Engineering students will be tied to a distinct blend of classroom lecture combined with practical field study. Utilizing a *"Special Topics in Engineering"* course, and a *"Civil Engineering Design"* course, college professors will have the ability to convey the idea that civil engineering is an actuality that exists on a global scale.

Engineering Education must take this a step further. Providing students the opportunity to directly experience these classroom lectures, by including a hands-on portion of the abovementioned college courses will facilitate the personalized growth of a civil engineering

student. The authors will provide to you a case study that exemplifies moving towards global competency for engineering students through travel and classroom lectures.

General Engineering Programs

At Salt Lake Community College (SLCC), in Salt Lake City, Utah, the Engineering Department offers both college level courses mentioned in the latter paragraph. SLCC offers multiple 'special topics' courses that are exceptionally useful for enhancing a civil engineering education. During the spring semester of 2011, a course titled *"Special Topics - Engineering Marvels,"* was offered to all SLCC students. It is within this 'special topics' course that a successful mixture of travel and classroom lecture has been achieved.

One very specific standout topic surrounds an American Society of Civil Engineers (ASCE) *"Modern Civil Engineering Wonder of the United States;"* The Hoover Dam. During November of 2010, a student chapter of civil engineering students was approached by the International Student Services (ISS) of SLCC. Vicky Wason [1], the Intercultural Coordinator for the ISS, had a proposal in mind that would involve SLCC international students in an engineering activity. Vicky had every intention of taking a group of international students on a tour of The Hoover Dam. Not really knowing where to begin, Vicky approached Dr. Nick M. Safai [2], of the SLCC Engineering Department, for his immediate knowledge of organizing a trip of this caliber. Dr. Safai has in the past arranged for civil engineering students to make the journey to The Hoover Dam.

Projects, Presentations, and Travel

Hoover Dam

This Hoover Dam trip offered a unique opportunity for civil engineering students to educate a group of diverse international students on an engineering marvel. The classroom lecture began with a preview of *"Hoover Dam* [3]*,"* from the Modern Marvels collection available on The History Channel. The Narrator inserted the following quote: *"The task monumental and for many, deadly. Building the world's largest dam in one of the most unforgiving climates on Earth. Nothing like it had ever been attempted* [3]*."* Each student's focus heightened and their interest grew as the episode unfolded. The civil engineering students, as well as the international students, were required to write a one page summary of the film. After the summary, each student was asked to express one aspect of The Hoover Dam that they would like to further explore. The vast majority of students expressed a desire to enter the dam and see the inner workings. The stage was set for the trip and anticipation was high for all parties involved.

Upon further review of the planned trip, Dr. Safai recognized an outstanding chance to further enrich the experience of the civil engineering students as well as the international students. The Colorado River Bridge had just been recently completed in October of 2010 [4], and was fully operational. The bridge was within reasonable travel distance and would offer unprecedented views and field study opportunities. With the Colorado River Bridge fresh on the mind of Dr. Safai, the international students were invited back to the 'special topics' course in order to enjoy material he had prepared specifically on the bridge. Once again each civil

engineering and international student created a one page summary followed by their choice for additional study. Without question, each student clearly wanted to walk the span of the Colorado River Bridge. After two full weeks of classroom lecture, the stage was set for a priceless opportunity to have a complimentary hands-on experience.

A group of civil engineering students, international students, and their respective academic advisors, left for The Hoover Dam in mid January of 2011. Initially the trip from Salt Lake City, Utah to The Hoover Dam took eight hours. It was an uneventful bus ride for those involved. Soon we began the trek down Nevada Highway 172 on our way to the Nevada / Arizona border. Traveling the Hoover Dam Access Road eventually opened up to wonderful views of the Colorado River Bridge on the right and The Hoover Dam off to the left.

Our collection of civil engineering and international students. Dr. Safai is third from the right on the bottom row.

Engineering Students Training & Educating Other Students

On the agenda for the group was a tour of the interior of the dam itself. Once inside the visitor's center, the civil engineering students and Dr. Safai were separated into groups that consisted of one civil engineering student and three to four international students. Each civil engineering student was given the opportunity to lead their respective group; answering any questions as well as pointing out specific civil engineering details to the international students.

This separation of students helped to provide the civil engineering students the chance to teach and reflect upon the materials and information they have gained while attending classroom lectures at SLCC. From personal experience, the international students in my group had very specific questions about the dam. Such questions as, *"How much power does this dam*

produce?," "What types of materials are being utilized in the underground tunnels in order to prevent the tunnels from collapsing?," and *"How does the hydroelectric portion of the dam actually work?"* These questions were all validated as we visited the actual power plant, as we walked the underground tunnels, and as we rode the elevators back to the surface.

Inside the belly of The Hoover Dam power generator housing.

The Colorado River Bridge

Once the interior tour of The Hoover Dam was completed, we travelled to the observation deck in order to have a preliminary view of the Colorado River Bridge. As a civil engineering student the first thing that I noticed was the enormous concrete pillars that help support the operational portion of the bridge. The huge sweeping concrete arch that allows the bridge to span the canyon walls was simply beautiful.

The international students were just as impressed as the civil engineering students. Once again the questions began; *"What type of bridge can this be categorized as?," "What is the difference between this bridge and a suspension bridge?,"* and *"What allows the bridge to support its own weight?"* The civil engineering students were simply impressed by the curiosity of this diverse group of international students. Our next destination was to walk as much of the Colorado River Bridge as we could handle.

A wonderful view of the Colorado River Bridge from The Hoover Dam observation deck.

Being able to visit this engineering marvel was, without question, the best possible way to validate and enforce our classroom lecture. In my opinion, once a civil engineering student is exposed to an engineering subject they run the risk of not retaining a proper amount of material, unless multiple learning options on the subject are utilized. In this case, taking the time to tour and enjoy The Hoover Dam shortly after a classroom lecture allowed for the classroom material to be retained and validated with sharp recall of the subject. Allowing the civil engineering students the ability to teach and discuss the subject material during this filed study further deepened their connection to their chosen career field.

The diverse group of international students that created the majority of this unique group of people each had one major thing in common. After spending hours together in a van, underneath and inside an engineering marvel, it was discovered that they all had an undeclared college major. They were in the process of discovering what it is they wanted to peruse as their future career. A few hours spent with civil engineering students had seemed to rub off on their educational outlook. A few international students began to express interest in engineering as their possible course of study. This on-site field study opportunity was a huge success all around.

TRIGA Nuclear Reactor

This trip was only the first step taken by SLCC civil engineering students as they move towards global competency. The SLCC civil engineering students have since visited a TRIGA Nuclear Reactor which is located and is present on the campus of the University of Utah. The material for this subject had been covered in the same fashion as The Hoover Dam. The initial

phase of study began with classroom lecture. Such topics as Three Mile Island and the Chernobyl disaster had been Dr. Safai's chosen method of delivery on nuclear science.

The nuclear reactor tour was coordinated with Dr. Dong-Ok Choe [5] of the University of Utah Nuclear Engineering program. This was another perfect example of how beneficial the combination of classroom lecture and hands-on field study will be for civil engineers and engineering students overall. Due to the nature of the project and the high security and risk involved, pictures were not allowed to be taken. Therefore we do not have any photos for this project. Also this was only for citizens of the United States. Non citizen participants were not allowed in the facilities.

STEM Outreach at Cottonwood Elementary Engineering Day

In November of 2011, SLCC engineering students were invited by Cottonwood Elementary to actively participate in an event devoted to the promotion of engineering to elementary students. The engineering community considers this particular practice a STEM (science, technology, engineering, mathematics) Outreach. SLCC engineering students were instantly drawn to the opportunity to once again teach and promote engineering through a simple lecture and hands-on approach.

SLCC engineering students began the process of selecting engineering discussions and presentations that were appropriate for the age group of the elementary student audience. A basic trebuchet structure was used to demonstrate the physics concept of tension. Paper airplanes combined with a simple fan were used to demonstrate the concept of aerodynamics. A bucket full of water was used to display water tension as a paperclip was lowered onto the surface of the water without sinking. Creation of backscratchers utilizing metal strips and a plastic fork were used to enforce team building skills as well as problem solving skills.

This is Keith Jenson, ASCE Student Member, assisting the student in producing a homemade backscratcher at Cottonwood Elementary.

Dr. Nick Safai and ASCE Student Member, Todd Ferrando, began the surface tension project by asking the elementary students a few questions before they started the demonstration.

Engineering Students Educating and Training Elementary School children

The Cottonwood Elementary STEM Outreach program was a huge success, not only for the elementary school student, but also for the SLCC engineering students. Each engineering student participant was able to help teach our future crop of engineering student the hands-on approach that will become crucial for the success of all engineering students as well as current engineers. This event was such a success that the SLCC engineering department has begun the creation of a STEM Outreach program that will be utilized in our local community in the near future.

A STEM Outreach program can have success on a much broader and global scale. Multiple classrooms and multiple children across the globe can benefit from interaction with engineering student who are willing to share STEM topics. The Cottonwood Elementary STEM Outreach program can be geared towards any type of classroom in any part of the world. I have a distinct vision of being able to travel outside of the USA and sharing STEM topics with a global audience. Being able to teach and interact with young children outside of the USA will allow engineering students the opportunity to grow and create a sense of global competency and awareness that will be essential for their future achievement.

Panama Canal

In order to take the next step onto a global scale, SLCC civil engineering students are in the process of creating a field study opportunity that will take them to another ASCE Civil Engineering Marvel; this time leaving the United States. During the education of civil engineering students at SLCC, each is required to attend a course titled *"Civil Engineering Design."* This engineering design course is a requirement of the Civil Engineering curriculum. For the first one third of the course, such topics as the Space Shuttle Challenger catastrophe and

The Aswan High Dam were presented as case studies. During the last two thirds of the course, one specific topic was chosen as the focus; the Panama Canal.

The Panama Canal is a huge testament to the difficulties and triumphs associated with civil engineering. We covered the Panama Canal in tremendous detail; such aspects as the economical, environmental, social and technical, were the topics of choice. Diving into the success and failures of Ferdinand de Lesseps, the sweeping outbreaks of disease caused by mosquitoes, the technical issues caused attempting to carve a path through the Culebra Cut, and the overwhelming change and victory brought by the United States of America [6]. This course brings to the civil engineering student the sense of scale that an engineering project can and will encompass. In order to create a sense of global awareness and engineering reality, SLCC civil engineering students will visit the Panama Canal in mid 2012 in order to experience this engineering marvel hands-on in the field. The Panama Canal was an engineering feat that encompassed a global network of countries and individuals. Exploring the Panama Canal and the more current Panama Canal Expansion [7] will allow SLCC civil engineering students to experience engineering on a global scale, therefore moving each one closer to a state of global competency and awareness.

Summary

The success of Civil Engineering students will be tied to a distinct blend of classroom lecture combined with practical field study. College professors must have the ability to convey the idea that engineering is an actuality that exists on a global scale. Engineering Education must take this a step further, providing students the opportunity to directly experience these classroom lectures, by including a hands-on portion of selected college courses. Allowing participation in a classroom lecture coupled with hands-on field study will exemplify the reality of moving towards global competency for engineering students.

Bibliographic Information

[1] - Vicky Wason
Inter-cultural Coordinator
International Student Services
Salt Lake Community College
4600 South Redwood Road
Salt Lake City, Utah 84123
801.688.8696 - Cell
vicky.wason@slcc.edu

[2] - Dr. Nick M. Safai; PhD
Professor & Chair
Engineering Department
Salt Lake Community College
4600 South Redwood Road
Salt Lake City, Utah 84123
801.957.4798
nick.safai@slcc.edu

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[5] - Dr. Dong-Ok Choe; PhD
Assistant Research Professor
TRIGA Reactor Supervisor
University of Utah
50 South Central Drive
Salt Lake City, Utah 84112
801.587.3066
d.choe@utah.edu

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