Hands Across the Sea: Lessons Learned from the U.S. Fulbright Scholar Experience in the State of Qatar

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Hands Across the Sea – The US Fulbright Scholar Experience in State of Qatar – lessons learned

Abstract:

Considering the impacts of ongoing globalization, it is important for researchers and educators to have dialogue and collaboration with their counterparts around the world. This possible collaboration has been facilitated through a Fulbright US Scholar program Experience in State of Qatar. The Fulbright US Scholar program sends approximately 800 American scholars and professionals per year to approximately 130 countries, where they lecture and/or conduct research in a wide variety of academic and professional fields [1]. The program was established in 1946 under legislation introduced by the late Sen. J. William Fulbright of Arkansas. The program's purpose is to build mutual understanding between people of the United States and the rest of the world [1]. The author experience as a US Fulbright Scholar at a host institution in Qatar involved teaching, outreach and exploring partnerships with academic institutions in the host country, including education research. The teaching component involved development and delivery of a course on Embedded Systems Design for engineering students. As a result, graduating students gained current skills needed by industry and were better prepared for the workforce. The educational strategies need in the course were designed to bring the recent technologies in embedded systems used worldwide in industry to the classroom to teach theory with new and industry-relevant tools. An engineering education research phase explored the reasons, challenges, and motivations for considering engineering as career among both male and female electrical engineering students. Results of the research will help us better understand the experiences of female engineering students in the Electrical Engineering Department at Qatar University. The purpose of this engineering education research project was to propose strategies that may help balance the gender gap in STEM fields and increase the representation of female students, mainly in engineering majors in US, based on the lessons learned from Qatar University study. The purpose of this paper is to discuss the author experience as a US Fulbright Scholar, in the specific areas of teaching, outreach, and research in engineering education.

I. Introduction

Considering the impacts of ongoing globalization, it is important for researchers and educators to have dialogue and collaboration with counterparts around the world. Qatar was an ideal country in which to implement this project because within the Middle East, Qatar is one of the most socially advanced and politically stable countries. Therefore, Qatar is an ideal location for collaborative education and research activities in the region. Qatar has placed a great emphasis on education. Qatar is currently considered a hub for science, engineering and technology education in the Middle East and gulf region. There is significant support for science, engineering, and technology through the Qatar Foundation [2], and a number of leading US universities have branch campuses in Qatar's Education City. Additionally, with the establishment of the Qatar Science and Technology Park (QSTP) in 2004 [3], Qatar has the first (and only one in the region) science park that links academia with industry and facilitates and promotes technology-based industries. QSTP is considered an international hub for applied research, innovation, and entrepreneurship.

This Fulbright US Scholars Program project involved teaching, offering guest lectures and participating in university events and outreach activities in the host country, and education

research. The teaching component involved development and delivery of a course on Embedded Systems for engineering students. The guest lectures involved presenting topics on how to incorporate “soft skills” into the curriculum to address industry needs. Through this effort, Electrical Engineering (EE) and Electrical Engineering Technology (EET) faculty in the host country learned new skills that will ultimately impact students in EE and EET throughout the country through a continuously updated curriculum. In turn, these graduating students will be better prepared for the workforce by learning current skills needed by industry. An engineering education research phase sought to identify the reasons, challenges, and motivations for considering engineering as career among both male and female electrical engineering students. The project’s research portion was directed toward understanding and proposing thoughts that may help balance the gender gap in STEM fields and increase the representation of female students, mainly in engineering majors in the US, based on the lessons learned from the study in Qatar.

II. Teaching

Microcontrollers are becoming one of the most exciting devices in history. The average future homeowner will have every aspect of their home designed around them. While an FPGA can serve as a control system, every other device – from lights, home electronics, and appliances – will be interfaced through microcontrollers. Utilizing these tools, a homeowner will be able to log into their “home” and control every electronic component from their handheld device. This same will likely be true for cars, businesses, and limitless other possibilities. An “Internet of Things” can only be possible with modern microcontrollers. One microcontroller can manage hundreds of sensors through a single I2C bus. A microcontroller is a system-on-chip integrated circuit, containing a processor, memory, and programmable input/output peripherals. The Embedded Systems curriculum implemented through this project provided students at Qatar University with a hands-on educational experience that is well-respected by industry.

During the author Fulbright fellowship, I taught two classes of Embedded Systems. The first class was for male students, with a total enrollment of fifteen students. The second class was for female students, with a total enrollment of 30 students. The course objectives included:

1. Understand the structure and organization of embedded systems and their suitability to solve specific engineering problems.
2. Describe the main principles behind the hardware and software design of embedded systems.
3. Implement and verify algorithms using a high-level language, such as 'C', for microcontroller or microprocessor based systems.
4. Describe the main principles of assembly language programming and how this relates to high-level language programming.
5. Understand the impact of design choices on power consumption in modern embedded systems.

Topics included an introduction to microcontroller architecture, instruction sets, C language compilers, microcontroller interfacing, microcontroller peripherals, and embedded system design. Case studies examined microcontroller-controlled systems as well as simulation and emulation of specific families of microcontrollers.

Hardware and Software Development Environment: For this project, laboratories were built on an Altium Designer and NanoBoard 3000 [4] a platform equipped with Xilinx Spartan-3AN chip, with Xilinx ISE, and Altium Designer 10 software development. Figure 1 shows both a NanoBoard 3000 and an Altium Designer. The NanoBoard 3000XN is an FPGA prototyping board with an integrated color TFT LCD panel, a variety of standard communications interfaces (e.g., RS-232, PS/2, USB 2.0), an IR receiver, a 4-channel 8-bit ADC, an 8-way general purpose DIP Switches, 8 RGB LEDs, 5 push-button switches, and a 5V DC power connector, providing a hardware platform to exercise the full-scale of functionality that the NanoBoard family can deliver. The tasking product of Altium Designer is the embedded software tool that can target a set of microcontrollers, such as PowerPC, MicroBlaze, ARM, and TSK51x. The target microcontroller for the class was TSK51x, which is an ASM51 instruction-set compatible 8-bit microcontroller [4].

Figure 1 Hardware and Software Platform

Regarding my teaching methodology, I incorporated an online textbook instead of using traditional textbooks. The online option enabled use of animations, responsive questions, and interactive exercises (as compared to static text and drawings) for presentation of the course material. Students valued this new experience, as it definitely improved their learning. Teaching was the most enjoyable experience; students, especially the female students, were very enthusiastic. I had 30 female students in my class and I was very happy and surprised to see this large percentage of female students considering electrical engineering as a career. This was surprising to me because we struggle in US to motivate minorities, especially females, to consider engineering as a career.

III. Research

While female students in STEM education are considered underrepresented, and are outnumbered by male students in the US, the situation is different in the State of Qatar. According to the latest edition of Qatar's Ministry of Development, Planning and Statistics released in March 2014, the number of female students attending college represented 65% of the total students enrolled at universities in the year 2011-12. Additionally, 60% of all graduates in Qatar are female. Qatar University is the first national university in Qatar with female students exceeding 70% of the student population [5]. In Qatar University's Electrical Engineering department, female students make up approximately 42% of the total student population [6].

With the goal of understanding of how Qatari female students have developed (and pursue) their STEM career interest, mainly in engineering, I sought to try to answers questions relevant to how Qatari female students perceive electrical engineering as a career. Student participants in this study included a group of thirty female students and fifteen male students in the Electrical Engineering Department at Qatar University. The survey was voluntary and anonymous. Students were surveyed on their motivations to consider engineering as a career. The study was conducted in spring 2014. The objectives of the survey were to collect information from students (both male

and female) on the reasons, challenges, and motivations for considering engineering as career. A set of questions was developed to measure and identify reasons for student interest in STEM, mainly electrical engineering, as a career.

Table 1: Male/Female Students Response - Part 1

Survey Questions	Male	Female
1. My school did prepare me extremely well for college?	3.00	3.46
2. Preparing female students for career in STEM should be a top priority for schools in Qatar	3.85	4.65
3. Comparing to other countries, Qatar is a doing a great job in teaching STEM	3.85	3.86

The first part of the survey consisted of three questions on the quality of K-12 education in State of Qatar in preparing students for a STEM careers. Students were asked to rank their viewpoints based on a scale of 1 to 5 with 5 being Strongly Agree and 1 being Strongly Disagree. Table 1 reflect student feedback, both male and female, on part one of the survey questions. The second part of the survey included a set of questions to understand why female and male students in Qatar are interested in STEM career. The research goals were to identify how male and female students in the electrical engineering department view STEM as a career and possibly utilize the data to help bridge the gender gap in the US. Students were asked to identify the reasons why he or she considered and why he or she decided on engineering as a career. Students were given a set of possible reasons and were asked to select all that applied. Table 2 reflects student feedback, both male and female, on part two of the survey questions.

Results of the survey show both similarities and differences between male and female students' responses. Regarding similarities, both male and female students equally reported that when compared to other countries, the State of Qatar is doing a great job in teaching STEM (question 3). Additionally, both male and female students equally considered the job potential for engineers in Qatar and the surrounding region as a main reason for choosing engineering as a career (question 4). Male students were more inclined to seek to make a difference and help to build the country (question 4). Regarding differences, male students were more definite about their career goals in their early childhood; 15% of males decided to study engineering in their early childhood (question 5). On the other hand, 0% of females reported "early childhood" as the time when they decided to study engineering. Another notable difference probably reflects a culture shift in Qatar, as 57% of female students reported that their parents had the most influence on their decision to study engineering, compared to only 23% male students who felt the same (question 6). Parents are now more open and enthusiastic to motivating their daughters to seek degrees (and jobs) in engineering fields.

Other similarities include identifying studying hard as the most important factor to success; both male and female students valued highly the importance of studying hard for achieving success. Both groups also reported that having a good school education and joining a good university are definite keys for success as well (question 7). Because of the historical stereotyping of engineering as a mainly male-dominated field, female students believe that preparing female students for a career in STEM should be a top priority for schools in Qatar (question 2). Data also showed a difference between males and females in viewing the role of supportive parents as a factor in success. While female students still feel a need for parent support, they tend to rely mainly on their hard work as a key for success. This is probably due to the fact that female students are more critical of their performance and tend to always challenge themselves. Female students in Qatar reported that their parents had the most influence on their decision to study engineering. Educating

parents on potential opportunities for female students in STEM education will play a considerable role in possibly offsetting the gender gap.

IV. Outreach

During my fellowship at Qatar University, I worked with the Arab Youth Foundation Venture through the US Embassy to plan and host the NASA global space apps competition in Doha, Qatar. This event is NASA's space app-oriented hackathon, which sought out local enthusiasts with skills in information and computing technology, app development, engineering and design to create new tools to make life in space - and on earth - better for humanity. Qatar University engineering students have done an excellent job and won the top three local awards; the story was been reported by the Gulf times [7].

To possibly develop collaboration agreements with academic institutions in Qatar, I visited the College of North Atlantic - Qatar (CNA-Q) to develop an articulation agreement to provide students a smooth transition from the CNA-Q Diploma in Engineering Technology program to my home university's respective engineering technology programs. CNA-Q is a satellite campus of a Newfoundland-based college (Canada). The articulation agreements are currently being developed. I also established partnerships with both Qatar University and College of North Atlantic – Qatar to establish a vibrant engineering education center focusing on reconfigurable electronics, QU-DigiTEC. QU-DigiTEC will provide training and educational resources and promote best practices for community college, university, and high school instructors to enable them to teach new hardware technologies to a broad range of students, especially Qatari nationals, giving them the opportunities to realize their interest and abilities, and to be ready to achieve the goals of Qatar

Table 2: Male/Female Students Response - Part 2

Survey Questions	Male	Female
4. What are the reasons you considered when you decided on Engineering as a career?		
a) It is my passion	46%	54%
b) The job potential in Qatar and regional	46%	46%
c) The starting salary for fresh engineer is attractive	23%	25%
d) Qatar is in need of Electrical Engineering graduates	38%	43%
e) Participating in clubs focused on engineering	8%	7%
f) There is an engineer in the family (Dad, Mom, Brother, Sister)	23%	29%
g) It is a very interesting and challenging field	69%	75%
h) My High School GPA was high to get me admitted in Engineering	54%	50%
i) My parents told me I had to	8%	0.00%
j) I want to make a difference and help building my country	46%	32%
k) I was motivated by a school teacher	8%	14%
l) Others, please specify:	0.00%	17%
5. When did you decide you wanted to study engineering?		
a) After joining the college	23%	29%
b) In high school	46%	57%
c) In middle school	15%	11%
d) In elementary school	0.00%	4%
e) Early childhood	15%	0.00%
6. Who had the most influence on your decision to study engineering?		
a) My parents	23%	57%
b) My Friend	15%	14%
c) My teacher	15%	7%
d) My sibling	8%	14%
e) My grandparent	0.00%	0.0%
f) Other relative	8%	7%
g) No one	38.5%	25%
7. How important is each factor to your success?		
a) Studying hard	92%	79%
b) Supportive Parents	54%	18%
c) A good school education	38.5%	32%
d) Joining a good university	46%	57%
e) Having a role model	30%	22%

National Vision (QNV) 2030 of a highly-skilled, technologically competent, motivated workforce preparing Qatar for a successful transition to a knowledge-based, digital-age future.

I also participated in Qatar University's annual departmental assessment report utilizing my experience as an ABET Program Evaluator (PEV). I presented to the audience about the need to focus on incorporating soft skills in the curriculum to address industry's need for employees who have not only a technical background, but a working understanding of the business and societal issues faced by today's professionals. In addition to learning the application of science and engineering skills, students in the Electrical Engineering department need to develop a range of personal and professional skills, such as teamwork, project management, entrepreneurship, communications, and finance.

I was also invited to serve as a jury member of the annual senior design project contest, judging five senior project teams and selecting the top three projects out of five total projects. I also served as external evaluator for a senior project titled "Design and development of an autonomous quad-rotor platform for IARC Competition."

V. Conclusion

This Fulbright U.S. Scholars Program project involved teaching, offering guest lectures, and participating in university events and outreach activities in the host country, and education research. While I enjoyed all aspects of the Fulbright experience, teaching was the most enjoyable experience, as the students – especially the female students – were very enthusiastic. Having thirty female students in my class, I was very happy and surprised to see this large percentage of female students considering electrical engineering as a career. This is in sharp contrast to the situation in the US, where we still struggle to motivate minorities, especially female, to consider engineering as a career. The enthusiasm that the women had for engineering was enlightening. With regards to the research experience, the results of the research component showed that Qatari female students' interest in STEM careers started in high school. Students reported that more emphasis on teaching math and science, and working closely with high school teachers on possibly infusing engineering exploration into the curriculum, will definitely help motivate and engage female students to pursue STEM career pathways.

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