New Orleans JAZZED about Engineering Education

Paper ID #15560

Educational Evaluation of a Faculty-Led Education Abroad Program in Renewable Energy

Dr. Tony Lee Kerzmann, Robert Morris University

Dr. Tony Kerzmann received both a Bachelor of Arts in Physics from Duquesne University and a Bachelor of Science in Mechanical Engineering from the University of Pittsburgh in 2004. After graduating, Tony Kerzmann enrolled in graduate school at the University of Pittsburgh where he graduated with a Master in Science and a Doctor of Philosophy in Mechanical Engineering, in 2007 and 2010, respectively. Currently, Tony Kerzmann is an associate professor at Robert Morris University, where his research areas include, hybrid concentrating photovoltaic systems, energy systems, life cycle assessment, sustainable product development, engineering entrepreneurship, alternative energy systems, renewable energy education and active learning.

Mr. Casey James McAndrew
Kendra Slis
Maria Elisabeth French
Ms. Katelyn Maione P.E., Robert Morris University

Educational Evaluation of a Faculty Led Education Abroad Program in Renewable Energy

Abstract

In recent years, there has been increasing demand and push for global experience through an academic setting. For would-be engineers this is even more important in this world of ever-increasing global collaboration and commerce. In an effort to provide students with global education opportunities, our university has developed and enhanced a Faculty Led Education Abroad Program (FLEAP). The FLEAP program provides students an opportunity to participate in short-term study abroad programs where they are taught curriculum within an international setting. These programs have proven to be an excellent example of engaged learning and provide students with a global perspective that is unparalleled in any classroom. This paper will present learning and global awareness gains. The data presented are from a survey that was conducted on all the students who participated in the ENGR2012 FLEAP and have travelled to Germany as part of the course. The results were very positive with focus categories in personal growth, education, cultural awareness, engineering concepts and energy awareness. The averages in these categories ranged from 3.51 – 3.73 on a Likert scale. This shows that the ENGR2012 Renewable Resources FLEAP course provided students with learning increases that were well above "slightly improved" in all of the focus categories, with the greatest gains in the Engineering Concepts category. Through the use of the survey results and interviews, we have garnered meaningful conclusions that quantify and qualify learning gains of the ENGR2012 course as compared to a traditional on-ground course. Along with the survey data and results, this paper contains the design and layout of the course as well as the learning objectives and experiential learning components of the FLEAP.

Introduction

Globalization, internationalization, and global citizenship are all terms that center on a way of thinking and living that involves a mixture of multiple communities, cities, regions, and nations[1]. In the world today these traits are essential to the development of a student as they make their way into their respective professions. One of the best ways for students to gain these traits is with a study abroad experience[1]. A study abroad is defined as educational programs that take place outside the geographical frontiers of the student's country of origin[2].

Today 1.5% of undergraduate students and 10% of graduate students are participating in study abroad experiences[1]. With all of these young adults experiencing the world there are some great changes that are beginning to show themselves in the students who have participated in a study abroad program. Skills that are directly applicable to today's world and many life skills are acquired during study abroad programs. These benefits range from personal growth to improvement in traditional learning and a better ability to market oneself to employers[3]. One of the many goals associates with study abroad opportunities is to "train future global leaders to be more effective, respectful of other cultures and political and economic systems." Through this goal students become more open minded, sympathetic and understanding of cultural and political aspects that may differ from those of their home country[4].

The Princeton review stated in 2016 that while on a study abroad experience students discovered new things about themselves, learned how to face challenges on their own, and how to work as a team with unknown colleges[5]. Study abroad opportunities also engage students in both globalization and internationalization. Globalization seeks to create relationships across cultures in terms of technology, education and migration, while internationalization is oriented more toward multilateral processes involving knowledge of specific countries in furthering development in business, educational, social and cultural relationships[6]. As a major aspect of study abroad trips, these two concepts will aid students in their ability to fit into an increasingly globalized society, which is a great asset for young adults who have recently or soon to be graduating college.

Many recent graduates find employment to be their number one priority. According to the University of California 97% of study abroad students were employed within one year of their graduation, while only 49% of other college graduates were hired during the same year long period. The study also found that 100% of study abroad participants increased their GPA after a study abroad experience[7]. This implies that not only could study abroad programs improve the personal lives and worldviews of college graduates, but they could also assist students in achieving better grades in the classroom while providing better career opportunities.

There is also a connection between study abroad programs and increased soft skills in students. Soft skills are moving higher and higher on the list of things employers are looking for in an engineer. CENews published the results of a survey they conducted that supported this claim saying that "[W]e've talked about [what] we need to incorporate perhaps more in the education, so that students [who graduate are] more prepared for a job, and that includes management skills, written skills, oral communication skills, ethics, technical skills, more broad-based knowledge, more emphasis on humanities." There is evidence that study abroad experiences, particularly semester long programs, improve soft skills such as writing, oral and other self-expression communication skills[8, 9]. Katherine Boettrich, the vice president of Communications and Sustainability Affairs for ABB Inc. stated that, "Early opportunities to study and learn in the global community help students become innovators and critical thinkers. It helps them better prepare to become international leaders of tomorrow[10]." Katherine is not alone in her sentiments; many employers seek out graduates that have international experience.

Robert Morris University has recognized the many advantages that studying abroad programs have provided students. Robert Morris University offers yearlong programs, semester long programs, and faculty led educational abroad programs (FLEAP). This paper focuses on the short term FLEAP programs, which usually include two weeks spent abroad studying course topics while learning about international culture[11].

Recently a survey was conducted through Robert Morris University regarding the benefits received from the ENGR2012 Renewable Resources course that takes place in Germany. We believe that the study abroad experience from this course positively affects personal growth, overall education, cultural experiences, engineering concepts, and energy awareness, and this survey has been designed to quantify the learning gains in these areas. The ENGR2012 Renewable Resources FLEAP has occurred three times in the past four years, in 2012, 2013, and

2015, and has involved a total of fourteen students. The survey was distributed to each of the fourteen students to gauge their perceived outcomes from the study abroad experience.

Renewable Resources Course Layout

The FLEAP course began as an extension of an existing course, ENGR2012 Renewable Resources. One of the positive aspects of combining the FLEAP with the course was that Germany is a perfect place to visit when studying renewable energy and sustainability because of the nationwide focus in these topics. Many of the technologies that were discussed in class could be experienced throughout Germany and this offered a great opportunity for students to receive experiential learning related to the topics covered in the course materials. Studies suggest that engineering students learn better as active learners and therefore we believe that being able to see, discuss, experience and evaluate renewable energy technologies has helped students fully grasp the course materials[12]. Because Germany is arguably the leading country in wide-scale implementation of renewable energy, the choice to incorporate Germany into an existing renewable energy course was a logical decision.

The FLEAP to Germany has taken place 3 times since 2013, bringing a total of 14 students to Germany. The first two times the course was taught, the course had a traditional in-class component and shortly after the end of the semester the group travelled to Germany for two weeks. The most recent 2015 FLEAP was different. Instead of the more traditional on-ground course, the students studied course materials, watched videos, completed assignment and engaged in discussions in an online Blackboard environment. The professor and the students met periodically throughout the semester to discuss travel arrangements and other details about the FLEAP. This method appeared to work very well and will continue in future courses. Throughout the semester the meetings were used to discuss German culture, language and to discuss preparations for travel. There were even mini-lessons on the German language, where basic German words and phrases were taught by the professor. In addition to the online course materials and the mini-lessons, the students had to keep logbooks during their travels and complete a final report with along with a final presentation video upon the completion of the study abroad (The final report guidelines can be found in Appendix 1). This course was used to assess ABET outcomes a, d, g, h, and j, listed below[13]. The course outcomes were incorporated in the survey to assess gains in the outcome categories with regard to the ENGR2012 FLEAP course.

> Outcome a: RMU graduates have an ability to apply knowledge of mathematics, science and engineering.
> Outcome d: RMU graduates have an ability to function on multidisciplinary teams
> Outcome g: RMU graduates have an ability to communicate effectively
> Outcome h: RMU graduates have the broad education necessary to understand the impact of engineering solutions in a global societal context.
> Outcome j: RMU graduates have a knowledge of contemporary issues.

The course provided the students with a comprehensive overview of renewable energy technologies including: biofuels, geothermal energy, hydroelectric power, hydrogen fuel cells, solar energy and wind energy. Forms of energy and potential uses from each renewable energy source were covered. The Spring 2015 online course included:

- Lectures: Students were asked to study lecture slides covering the course topics (listed in Appendix 2).
- Readings and Assignments: Students were given 2 readings along with a short paper related to the readings. They were also given 4 additional readings with a connected assignment.
- Online Discussions: Students were asked to participate in weekly online discussions related to sustainability and renewable energy in Germany. The discussions included videos and short readings, where the students were asked pertinent questions and asked to engage in an online discussion.
- Final Exam: The final exam was given to the students before traveling to Germany and covered the course materials from the lecture slides.
- Final Report and Presentation: The students were assigned a Final Report and Presentation that was due 3 weeks after returning from their travels. The guidelines are outlined in Appendix 1
- Travel Logbook: The students were asked to keep a logbook of their personal experiences along their travels, including experiences related to renewable energy and sustainability.

FLEAP Organization and Site Visits

The FLEAP is organized around a handful of educational site visits. An itinerary of the site visits was established prior to departure, and the site visits varied for each of the three FLEAPs. In years past students visited German Universities studying renewables, offshore wind turbines, a heliostat field, and other renewable educational sites. During the FLEAP in May 2015, students traveled to four renewable energy sites: (1) Bundesverband WindEnergie - a wind farm in Cologne, (2) Solar Energie - a company that installs solar systems onto the roofs of homes and businesses, (3) Adlershof – a science-focused industrial park that is home to over 1,000 companies and a University Institution, most of which integrate renewable energy into the buildings and (4) Ketzin CO_2 Storage Facility - an experimental site that conducts tests on carbon capture and sequestration technologies . These site visits provided the students with hands-on examples of what was taught in the Renewable Resources course during the weeks prior to their travel.

At the Bundesverband WindEnergie site, students climbed to the top of a wind turbine where they were shown the inside of the nacelle (the housing for the gearbox and generator). Here they were able to visualize the various parts of the turbine itself, and expand their knowledge on how it worked fundamentally. Students also learned about the maintenance required, cost and energy output for each turbine. At the time of the site visit, the specific turbine that the students climbed had produced roughly 45,338,000 kWh of electricity since its initial installation[14]. The tour of Solar Energie exemplified to students the many uses of solar energy by not only explaining the different types of solar cells, but also by touring students through their demonstration house. This house utilized many different types of solar cells on several surfaces of the home including the roof, and siding. Solar Energie demonstrated to students how they monitored the solar electricity output from the solar panels, and how they were both utilizing and storing it. While these site visits were very clear with their impact on renewable resources and energy in Germany, the final two site visits were more experimental.

Figure 1: Bundesverband WindEnergie Site

Adlershof was an industrial park that ran primarily on renewables. Many of the companies experimented with new technologies and cutting edge research. The park was home to many companies with thousands of employees, as well as Humboldt University. The students took a tour of the park and learned about the different strategies utilized to either obtain renewable energy or conserve energy within the buildings. Ketzin's CO_2 Storage Facility was the last site visit, and was completely experimental. Students were taken through the steps of the experiment and shown the on-site equipment that had been used. The experiment was beneficial for the students by allowing them to visualize the concept, learn about how to conduct such a large scale experiment, and to learn about the aspects that affect the future success of such a project. Aside from these renewable resource site visits, the FLEAP allotted for cultural and historic site visits as well[15].

Figure 2: Ketzin CO_2 Storage Facility

Culturally, students were exposed to three cities within Germany where they went on historical site visits, worked through language barriers each day, and immersed themselves in an entirely new world both socially and emotionally. These experiences are meant to give students a better understanding of cultural differences, and sensitivity to different norms throughout the world. Throughout the FLEAP travels, the students not only received a real-world understanding of renewable energy and sustainability, but received invaluable lessons related to international culture, politics, international perspective, travel, and language.

Figure 3: Adlershof Science Industrial Park

Learning Objectives

Experience-based learning is a widely accepted form of learning. One of the many examples of experience-based learning is that of education abroad programs. According to Kolb's experiential learning theory, experiential learning is "the process whereby knowledge is created through the transformation of experience[16]." There are four steps in the learning cycle: 1) Concrete Experience 2) Reflective Observation 3) Abstract Conceptualization 4) Active Experimentation. It is fairly simple to draw parallels between the steps in the learning cycle and the events and tasks completed in the FLEAP course.

An excellent example of a concrete experience from the FLEAP was when the group climbed the wind turbine. While it may be common for students involved in renewable energies to understand how a wind powered turbine works it is very rare that a student has the experience of being inside a working, moving nacelle. From that concrete experience the students in the FLEAP were required to write a paper about their personal experience and throughout the FLEAP; students were asked to keep a daily log of their activities and experiences. Both of these actions helped to reinforce the reflective observation of Kolb's theory. The abstract conceptualization was achieved in the classroom and through online work that was completed prior to travel. Before leaving for the abroad program there were readings and a final exam that helped prepare the students. Active experimentation is evident in the final report and presentation where the students were asked to write a paper and record a video presentation of their experience.

Along with the four steps in Kolb's experiential learning theory, there are also a handful of key concepts that were required to fully develop an experiential based knowledge of the subjects.

According to Andresen there are some elements that must exist in order for the student to gain "usable knowledge": students must be fully involved mentally and physically, trust and respect must exist between the instructor and students, students need some type of previous knowledge about the topics, and opportunities must exist for the students to actively discuss their experiences with one another while still participating[17]. There was a great sense of trust and respect amongst the group as a whole and between the students and instructor throughout all of the FLEAPs. The group in its entirety would make jokes together and converse about the day's events and often draw comparisons to the material that was read in class and experiences from back home. Overall, the FLEAP encapsulated the majority of the needs represented for experiential learning to become usable knowledge. The FLEAP gave perspective to the conceptual course materials and brought them to life through the experiences of the students' travels and site visits.

Survey Tool and Methodology

In order to quantify the desired outcomes derived from the FLEAP we created a survey using the QuestionPro survey website. Using a survey was the most effective way for us to collect information and data to describe the characteristics of our target population of students who have participated in the FLEAP. In this particular case we decided to use an evaluation survey, a survey which is used to learn about the impact of programs and/or policies. The evaluation survey can also be used to explore relationships and examine attitudes and beliefs about the subject matter[18].

When designing an effective survey tool it is important to consider the project goals, survey sample, survey methodology, the development of questionnaire items, how the questionnaire is to be administered, and finally how the data and results are going to be summarized and reported.

Our project goal was to measure and determine the effectiveness of student participation in the FLEAPs versus the traditional on ground classroom. The survey sample included all students who participated in the ENGR2012 FLEAP over the last 4 years at Robert Morris University. The survey methodology we chose was an on-line survey questionnaire administered through the QuestionPro survey tool website. The students selected for the survey sample were emailed a link to participate and complete the survey. A disclaimer was also placed at the beginning of the questionnaire, explaining the survey and notifying the participants that they could exit the survey at any time. Participation in the survey was completely voluntary. In developing the questionnaire items it was important to first determine the variables of interest in the study before developing the actual questions. This is an important key to developing a successful survey because it avoids asking unnecessary questions or asking for unnecessary details and it also ensures that the researchers are gathering relevant data. When identifying the variables of interest for the study we decided to focus on five areas: energy awareness, personal growth, education, engineering concepts, and cultural awareness. The questions included in the survey were categorized into the five areas of focus. By having these five focus areas established upfront it made it much easier to determine the types of conclusions that we hoped to make from the results. Each of the questions asked in the survey were close ended and the participants answered each question by selecting their answer from on a Likert scale. In terms of how the survey was to be administered, the online survey was the best way for us to receive the results back in a timely fashion, and it also provided the best way for us to reach all of our participants.

In total we received 12 complete responses out of the 14 students that were invited to participate. All survey partial responses were not included in the results and conclusions. Finally, we decided to summarize and report the data using graphs and charts in order to be able to visually display the results of the study.

Overall, the survey proved to be a successful way in which to measure and meet our project goals of determining the learning effectiveness of student participation in FLEAPs versus the traditional on ground classroom.

Student Feedback and Survey Results

The results have been categorized by the focus areas that have been previously discussed. In an attempt to display the results as clearly as possible, we first organized the results of the 26 total survey questions into categories, as can be seen in Appendix 3. Special attention should be paid to questions a, b, o, r, and s, as they were designed to quantify gains in ABET outcomes a, d, g, h and j, respectively. All of the questions followed the same Likert scale, as shown below.

Likert Scale Used in the Survey:

1 = Greatly Diminished
2 = Slightly Diminished
3 = Slightly Improved
4 = Greatly Improved
5 = N/A

Focus Category - Personal Growth:

The personal growth category focused on determining what affects the FLEAP had on student's growth as it pertains to maturation and life skills. The questions focused on the way global experience affects how students function on multi-disciplinary teams, communicate effectively, and willing they are to travel. Results from the five questions were all very positive with most answers being answered "slightly improved" and "greatly improved" and an overall category average of 3.51 which was the average of all the participants' responses to questions a through f.

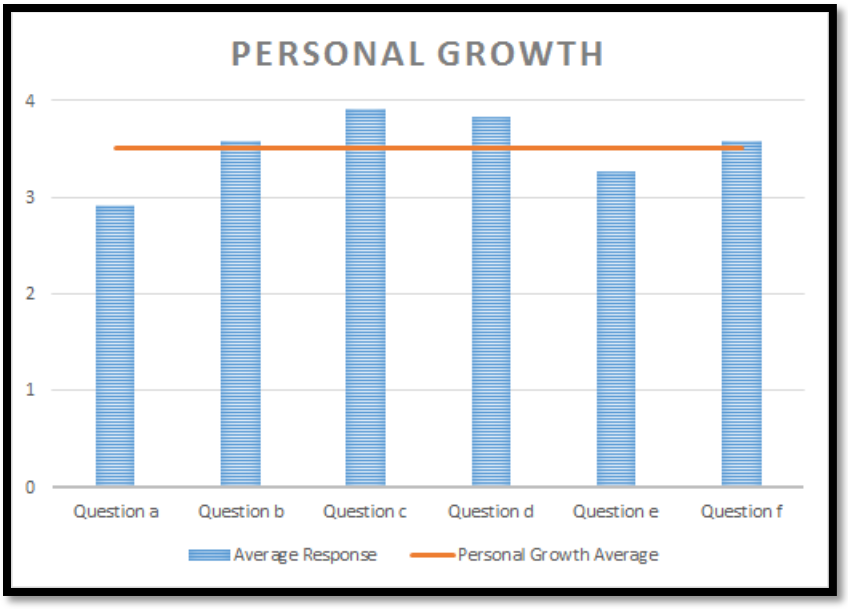

Figure 5: Results for the Personal Growth Category of the Survey

Focus Category - Education:

This category focused on the educational value that each participant believed was increased by the FLEAP. The questions were geared toward personal learning opinions and how the educational levels of an in classroom course compared to that of the abroad program. As can be seen in Fig. 2, the results were very promising with most of all of the questions scoring well above the slightly above level. The average score for this category was 3.63, which was the average of all the participants' responses to questions g through l.

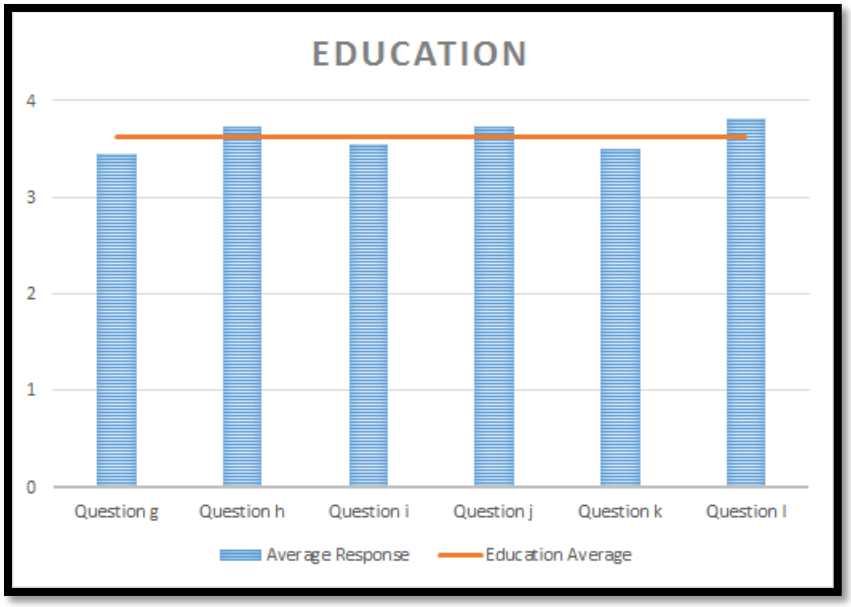

Figure 6: Results for the Education Category of the Survey

Focus Category - Cultural Awareness:
This category of the survey focused on determining if the FLEAP provided a change in the participant's cultural awareness. The questions focused on assessing the students' understanding of the culture of different countries and viewpoints of the international market. Results from the five questions were all relatively positive with most questions being answered as "slightly improved" or "greatly improved." The overall category average was 3.56, which was the average of all the participants' responses to questions m through q.

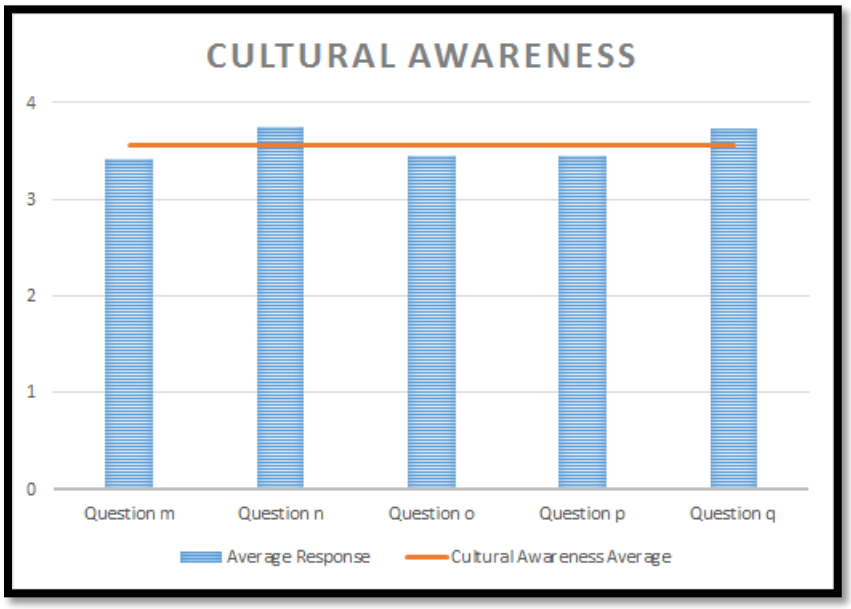

Figure 4: Results for the Cultural Awareness Category of the Survey

Focus Category - Engineering Concepts:
The Engineering Concepts category of questions was designed to determine any gains in the engineering knowledge of the students. The questions focused on areas such as the application of mathematics, science and engineering principles as well as the impacts of engineering on a global and societal level. The results from the survey were very promising. The survey showed that the engineering concept gains were well above the "slightly improved" level. The overall category average was 3.73, which was the average of all the participants' responses to questions r through u.

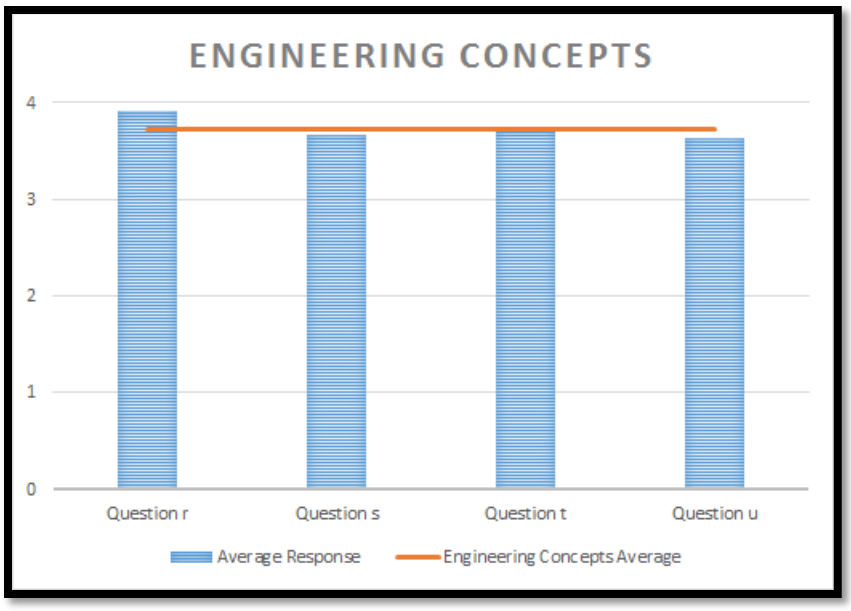

Figure 7: Results for the Engineering Concepts Category of the Survey

Focus Category - Energy Awareness:
This category of questions focused on determining what affects the FLEAP had on student's knowledge regarding energy. The questions focused on Germany and the United States, and general interest in the topic. Results from the five questions were all very positive with most answers being answered "slightly improved" and "greatly improved." The overall category average was 3.70, which was the average of all participant responses to questions v through z.

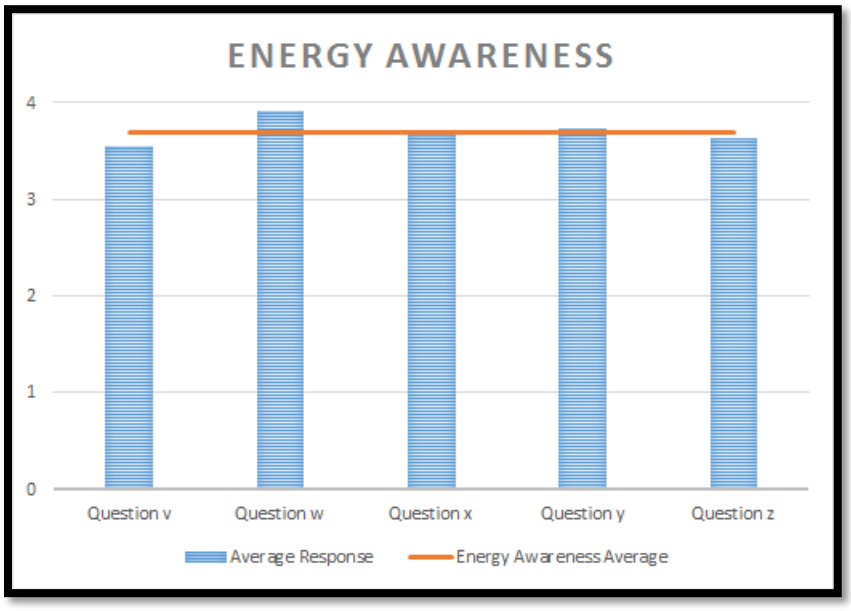

Figure 8: Results for the Energy Awareness Category of the Survey

Conclusions

Globalization and the ability to market oneself is a necessity in today's job market. Participating in a study abroad is one way that students can acquire the knowledge, perspective and skills necessary to become a well-rounded individual. Robert Morris University has made study abroad programs one of the top priorities of the university and this study was just one of many examples of how international experience can enhance the education of students.

While in Germany, students had the opportunity to experience a new culture while learning about renewable resources. They then had time to reflect upon it, conceptualize it, and will hopefully utilize this knowledge in future experiences. The research team used the QuestionPro survey website in an attempt to discover if students perceived the FLEAP as a truly positive experience. The results were very positive with category averages ranging from 3.51 – 3.73 on a Likert scale. This shows that the ENGR2012 Renewable Resources FLEAP course provided students with an increase that was well above "slightly improved" in all of the focus categories, with the greatest gains in the Engineering Concepts category.

Overall, all of the participant responses were extremely positive giving our team valuable evidence that the ENGR2012 FLEAPs improved the students' knowledge of mathematics, science, and engineering, as well as increased cultural awareness, improved life skills, and increased the ability to retain course knowledge. The students were able to function as a team during the ups and downs of international travel and gathered important experiences in overcoming language barriers. Finally, students were able to see contemporary issues firsthand and visualize engineering solutions to one of the world's biggest problems, the future of energy.

Out of all the survey questions, question (a) in particular clearly had the lowest score. Question (a) states, "The FLEAP experience affected my ability to function on a multi-disciplinary team." Although the score was very close to the "slightly improved" level, it appears to be an area of weakness and therefore the researchers will try to determine the reasoning for the low score and if there are any necessary improvements to the FLEAP that would increase the ability of future FLEAP travelers to function on a multi-disciplinary team. One possibility may be the wording of statement itself. The use of the words "multi-disciplinary" for a group of engineering students (although from different engineering disciplines) may lead to confusion for the participants. The wording of this question will be revisited by the research team. Throughout there FLEAP there was not an emphasis on teamwork and therefore this may be an area of improvement for future FLEAPs.

This study has provided helpful survey data that will help to improve future FLEAPs. The results, albeit very positive, have some areas that will be revisited and include: multi-disciplinary teamwork (as discussed above), understanding of the international market, knowledge of contemporary issues, international communication abilities, understanding of the impacts of engineering in a global context, course material retention, understanding of the course material, and awareness of energy policy. These areas will be evaluated to determine whether improvements can be made in future FLEAPs.

References

[1] Green, M. F. (2012*). Global Citizenship: What are we Talking About and Why Does It Matter?*. Trends & Insights for International Education Leaders, NASFA, p. 1-4.

[2] Carlson, J.S., & Widaman, K. F. (1988). *The Effects of Study Abroad During College on Attitudes toward Other Cultures*. International Journal of Intercultural Relations, 12(1), p. 1-18.

[3] Smith, D. E., & Mitry, D. J. (2008). *Benefits of Study Abroad and Creating Opportunities: The Case for Short-Term Programs*. Journal of Research in Innovative Teaching, 1(1), p. 236-246.

[4] Dwyer, M., and Peters, C. (2016). Benefits of Study Abroad. Retrieved from:http://www.iesabroad.org/study-abroad/news/benefits-study-abroad#sthash.EK0DvOYS.dpbs

[5] Princeton Review. (2016). *Why Study Abroad*. Retrieved from http://www.princetonreview.com/study-abroad/college-abroad/why-study-abroad

[6] McCabe, L. T., (2001). *Globalization and Internationalization: The Impact on Education Abroad Programs*. Journal of Studies in International Education, 5(2), 138-145.

[7] University of California, Merced. (2016). *What Statistics Show about Study Abroad*. Retrieved from https://studyabroad.ucmerced.edu/study-abroad- statistics/statistics-study-abroad

[8] Spodek, S., & Mook, D. J., & Gerhardt, L. (2003). *Study Abroad: Impact On Engineering Careers*, Paper presented at 2003 Annual Conference, Nashville, Tennessee. https://peer.asee.org/12116.

[9] Murphy, C., & Fauerbach S. (2001). *The CENews Roundtable: What employers want from new hires — and what they're getting*, CENews. March 2001.

[10] Boettrich, K. (2003). *ABB and Global E^3 award scholarships to three women for engineering study Abroad,* Press release, February 14, 2003.

[11] Robert Morris University. (2014). *Germany – Faculty-Lead Program*. Retrieved from http://global.rmu.edu/education-abroad/faculty-led-programs/germany-faculty-led.

[12] Dunn, R., & Carbo, M. (1981). *Modalities: An Open Letter to Walter Barbem Michael Milone and Raymond Swassing*. Educational Leadership, p. 381-382.

[13] Accrediting Board for Engineering and Technology. (2015). *ABET Criteria for Accrediting Engineering Programs Effective for Reviews during the 2015-2016 Accreditation Cycle*. Retrieved from http://www.abet.org/wp-content/uploads/2015 /05/E001-15-16-EAC-Criteria-03-10-15.pdf.

[14] Aachen Hat Energie. (2016). Retrieved from http://www.aachen-hat-energie.de/wind/allgemeines.htm#

[15] Adlersof. (2016). *Humboldt University's Adlershof Campus*. Retrieved from http://www.adlershof.de/wissenschafts-campus/humboldt-universitaet-zu-berlin/ueberblick/.

[16] Kolb, D. (1984). Experiential Learning: Experience as the Source of Learning and Development. Prentice-Hall, Englewood Cliffs, NJ. p. 38.

[17] L. Andresen. (2000). *Understanding Adult Education and Training, 2^{nd} ed.*, Allen and Unwin Publishers, in Foley, G., p. 225-239.

[18] Colton, D., & Covert, R.W. (2007). *Designing and Constructing Instruments for Social Research and Evaluatio*n. Jossey-Bass, San Francisco, CA. p. 10-11.

Appendix 1

ENGR/ENVS 2012 Renewable Resources Report & Presentation (50% of Total Grade)

- Individual Project Reports are due (10 page min., not including Title Page and References)
- *Paper Format*: 12 Times font, single spaced, 1 in. margins, including images
- *Video*: 10 Minute Video(s) presented on Friday, June 12th
- *Logbook*: You will keep a logbook along your travels and will turn it in with your final report

A) PAPER (30% of Total Grade):

- Background: (1/2 pages)
  - Briefly describe the reason for the FLEAP to Germany
  - Describe the importance of renewable energy in our society and for the future
  - Describe the "Three Pillars of Sustainability"
- Introduction: (1/2 page)
  - Describe the renewable resources that are compared in your paper
  - Briefly explain how you will assess U.S. and German perspectives
- U.S. Renewable Energy: (1-2 pages)
  - Give a detailed a breakdown of energy production and consumption
  - Describe relevant energy, environment, economic and social policies
  - Explain the latest technologies and research in renewable energy
- German Renewable Energy: (1-2 pages)
  - Give a detailed breakdown of energy production and consumption
  - Describe relevant energy, environment, economic and social policies
  - Explain the latest technologies and research in renewable energy
- Energy Policy: (1-2 pages)
  - Explain differences in the way Germany and the U.S. have implemented renewable energy
  - Give you opinion on which implementation is better and why
- Cultural Learning: (1-2 pages)
  - Describe U.S. and German perspective on renewable energy
  - Describe general differences in U.S./German culture with regard to Energy and Environment
- Personal Experience: (1-2 pages)
  - Describe any personal experiences that you may have had with German individuals that changed your perspective about energy, politics, culture, etc.
  - Describe which aspects of your travels had the greatest impact on your experience
- Conclusion: (1/2-1 page)
  - Give an overview of what you learned throughout your travels.
  - Discuss the biggest differences in energy policy and culture.
  - Give your thoughts on how both the U.S. and Germany could improve their use of renewable energy.
- Literature Cited:
  - At least 5 sources
  - *Example Reference:* [1] A.B. Smith, C.D. Jones, and E.F. Roberts, "Article Title", Journal, Publisher, Location, Date, pp. 1-10.

B) VIDEO(S) (20% of Total Grade): You will be making a total of at least 10 minutes worth of video that will be uploaded and presented 2 weeks after returning from Germany. You can make 1 long video or break the 10 minutes into smaller videos. Video quality and content will be a major portion of your grade.

- Content: At least 1 of the videos should describe a renewable energy technology that was visited. If you are doing multiple videos, you could have a video describing sightseeing, culture, and any other related events.
- Quality: The video should be well edited and your voice should be describing the details of the video content.

Appendix 2

ENGR/ENVS 2012 Renewable Resources - List of Course Topics

Chapter 1: Energy Overview, Policy and Indicators

1. Sustainability, Sustainable Energy
2. Energy: Oil, Coal, Natural Gas, CO2, Fossil Fuel Limitations
3. Public Policy
4. Energy Consumption: Buildings, Transportation, and Electricity
5. Growing Energy Demand
6. Energy Indicators: Energy/Capita, Energy Intensity (Energy/GDP)
7. OPEC: Organization of Petroleum Exporting Countries, mainly located in unstable regions

Chapter 2: Fossil Fuels and Limitations

1. Oil and Coal Reserves
2. Oil Discovery vs. Demand trends
3. Current Reserve Locations
4. Peak Oil and Peak Coal
5. Oil Sands: Surface Mining
6. Climate Change: Temperature Measurements
7. Temp vs. CO2 trends
8. Climate Change Consequences
9. CO2 reduction
10. Energy Efficiency
11. Building Efficiency
12. Renewable Energy Growth: Wind, Solar and Biomass

Chapter 9: Power and Distribution

1. How Electricity is produced
2. Power = Current x Voltage (P=IV)
3. AC vs. DC
4. Low Voltage vs. High Voltage
5. Coal Power Plant Efficiency = 33%
6. CCPP: Combine Cycle Power Plant, up to 60% efficient
7. Power Grid

Chapter 10: Smart Grid and Energy Storage

1. Centralized vs. Distributed Energy
2. Smart Grid
3. Energy Storage: Battery, Plug-in Hybrid Vehicles
4. Electric Vehicles: ¼ cost of gas and ½ CO2 Emissions
5. Electric Meter
6. Net Metering

Chapter 11: PV and Solar Thermal Systems

1. PV History
2. Photoelectric Effect
3. Air Mass Ratio
4. Silicon Cell Fabrication
5. PV System Basics: Cell, Module, Array
6. PV Technologies: mono-Si, multi-Si, ribbon-Si, a-Si, CIGS, CdTe, Dye-Sensitized, and Polymer
7. PV Market Share: Majority = silicon cells
8. World Leaders in Solar Installed and Capacity
9. Define BIPV
10. PV Systems: Direct Use, Stand Alone, and Grid Tie

11. Single Axis versus Dual Axis Tracking Systems
12. Define SREC
13. What are Standard Test Conditions (STC)?
14. Multijunction Cells
15. Solar Concentration: Fresnel Lens, Parabolic Trough, Parabolic Dish, and Power Tower

Chapter 12: Large Scale Solar and Wind

1. CSP: Parabolic Troughs, Linear Fresnel Reflectors, Power Tower, and Parabolic Dish
2. How does a Parabolic Trough Plant Work?
3. Parabolic Trough Max Concentration and Max Fluid Temperature
4. Parabolic Trough Heat Transfer Fluids: Thermal Oils, Water, Molten Salts
5. Spain and SW USA LCOE
6. PV Increase in Existing World Capacity
7. Wind Turbine Major Components
8. Power as a Function of Velocity and Blade Swept Area
9. Grams of CO_2 per kWh for different power sources
10. Wind Turbines = 30,000 bird deaths per year

Appendix 3

FLEAP Survey Questions:

Scale: 1=Greatly Diminished 2=Slightly Diminished 3=Slightly Improved 4 =Greatly Improved 5=N/A

Personal Growth:

a. The FLEAP experience affected my ability to function on a multi-disciplinary team.*
b. The FLEAP experience affected my ability to communicate effectively.*
c. My participation in the FLEAP trip provided me with experiences that will help me after I graduate.
d. Participation in the FLEAP trip made me more willing to travel or move for my future career.
e. The FLEAP trip has given me better examples when marketing myself in an interview.
f. I feel that I can apply the knowledge and experiences gained on the FLEAP trip to situations in my life.

Education:

g. The FLEAP trip course required more self-teaching than an in class course.
h. On the FLEAP trip I learned through hands on experiences more than an in class course.
i. I can recall information presented on the FLEAP trip better and faster than information from an in class course.
j. Overall the FLEAP trip increased my learning experience more than an in class course
k. The FLEAP helped me to overcome adversity in a learning environment.
l. The FLEAP placed physical understanding to previously conceptual topics.

Cultural Awareness:

m. There was improvement to my understanding of the international market through the FLEAP.
n. The FLEAP trip broadened my understanding of cultural diversity.
o. The FLEAP experience affected my knowledge of contemporary issues.*
p. The FLEAP trip has increased confidence in my international communication abilities.
q. The FLEAP trip has given me the ability to adapt in an international environment.

Engineering Concepts

r. The FLEAP experience affected my ability to apply knowledge of mathematics, science and engineering.*
s. The FLEAP experience affected the education necessary for me to understand the impact of engineering solutions in a global and societal context.*
t. The FLEAP trip aided me in retaining the information learned in the course
u. The FLEAP trip gave me a better understanding of the material

Energy Awareness

v. The FLEAP trip has greatly influenced my awareness of energy policy over a typical onground course.
w. The FLEAP helped me to quantify the differences in energy policy between the two nations.
x. Participation in the FLEAP trip increased my interest in renewable resources.
y. The FLEAP trip gave me an opportunity to expand my knowledge on different protocols regarding energy
z. The FLEAP allowed me to understand differences in the use of renewable technology in the two nations.

* indicates that question is designed to quantify ABET outcomes a,d,g,h and j, respectively