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Sustainability Education in a Global Era

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Sustainability Education in a Global Era

Abstract

We live in an era of expanding globalization. The interconnectedness of the world has been increased in all aspects of life. The International Monetary Fund identified four basic aspects of globalization: trade and transactions, capital and investment movements, migration and movement of people, and the dissemination of knowledge. [1] For the United States to continue to be at the forefront of science and technology, global education is of extraordinary importance. Therefore, we must develop a workforce of engineering students with the skills and knowledge needed for a more responsible and competitive participation in the international research setting of the twenty-first century. [2]

Education, culture, employment opportunities, and international trade and connectivity are among the several benefits that globalization has on our lifestyle. Despite the benefits, globalization also contributes to the challenges for the century ahead. Globalization has fostered faster production, trade and consumption of material goods unparalleled in our collective history. This has increased the ecological footprint of human activities accentuating the major environmental challenges that we experience – such as global warming, cross- boundary water and air pollution, all of which await engineering solutions. [3] The survival of the human race is directly dependent on the environment, and it is commonly agreed that education is the most effective means that society possesses to confront the challenges of the future. Therefore, sustainability education plays a key role in shaping the world of tomorrow.

This paper describes a number of pioneering education, training and outreach initiatives in the area of sustainability being implemented at the University of Alabama at Birmingham (UAB).

Key Words: Globalization, Sustainability, Engineering Education

Introduction

The concept of globalization is a relatively recent term. By definition, globalization is the process of international integration arising from the interchange of world views, products, ideas, mutual sharing, and other aspects of culture. The integration of markets and nations have allowed individuals, companies and nation-states to reach around the world faster and cheaper than ever before [5], which has affected many areas of human life, among those being education.

Globalization, together with technological advancements, has maximized the access and dissemination of knowledge within our society. As a result, education is undergoing constant changes, from the context in which educators operate to the students experience with both formal and informal education. [6] It is imperative to understand the importance that global education has in order to continue to prosper and to exercise leadership in this new global context.

Global education, as defined by Robert G. Haney, means “learning about those issues that cut

across national boundaries and about the interconnectedness of systems, ecological, cultural, economic, political, and technological. Global education involves perspective taking, seeing things through the eyes, minds, and hearts of others; and it means the realization that while individuals and groups may view life differently, they also have common needs and wants." [7] Therefore, for the United States to continue at the forefront of science and technology, global education is paramount to developing a workforce of engineering students with the skills and knowledge needed for a more responsible and competitive participation in the international research setting of this fast-changing and interdependent world.

Having recognized the importance of educating the students in a global context, sustainability education is a critical component in finding solutions for future environmental challenges as well as achieving a sustainable balance capable of protecting our planet and human habitats. Over the past twenty years globalization has had a mixed impact on both developed and developing countries. Even though this process has been generally positive, there are substantial challenges resulting from a more interconnected and global world which await engineering solutions. [8] Although indirectly responsible, globalization has helped accentuate major environmental damages that we are currently experiencing by having an impact on global warming, deforestation, ozone depletion, biodiversity, oceans, and pollution. [9] The magnitude of the threat to the ecosystem is linked to anthropogenic activities. Resource use, waste production and environmental degradation are accelerated by population growth. They are further exacerbated by consumption habits, certain technological developments, and particular patterns of social organization and resource management. [10] To sustain progress in human development, far more attention needs to be paid to the impact human beings have on the environment. Otherwise the finite resources of the planet will be depleted to the detriment of both the global ecosystem and humanity.

The survival of the human race is directly dependent on the environment; therefore, sustainability education will play a key role in shaping the world of tomorrow. If globalization follows a sustainable path it can be compatible with a healthy and resource-rich environment that can satisfy the needs of future generations.

Having established the importance of sustainability education in this era of globalization, this paper describes the following five initiatives that UAB has undertaken under the umbrella of the Sustainable Smart Cities Research Center (SSCRC). These initiatives emphasize innovative and diverse approaches for student training and education in the area of sustainability and aim at reaching a wide spectrum of student education levels – middle school, undergraduate, master's, and PhD levels.

- Youth Champions Program
- Summer Enrichment Program
- International Research Experience in the Netherlands and Egypt
- Master's Degree in Sustainable Smart Cities
- Interactions with the City

A brief description of the UAB Sustainable Smart Cities is given in the following section.

Interdisciplinary Framework - The Sustainable Smart Cities Research Center

Sustainability is a multidisciplinary field that incorporates many disciplines of science and knowledge. A salient weakness of sustainability education is its tendency to overlook the multidisciplinary and complex nature of sustainability. [11] For this reason, these sustainability education initiatives are hosted under the umbrella of the UAB Sustainable Smart Cities Research Center, an enabling platform for interdisciplinary collaboration to understand and transform the impact of urbanization at the scientific, economic, and human levels. The center's contribution to sustainability derives from the university's unique capabilities to generate new knowledge and cutting-edge science.

The main goal of the SSCRC is to foster cross-disciplinary research, training, and outreach that integrate health, socio-economic impacts, and infrastructure design for the purpose of developing innovative solutions for sustainable smart cities and communities. Specifically, the SSCRC brings together multidisciplinary faculty with diverse expertise (green construction materials; sustainable building and design concepts; social impacts of technology; modeling and simulation; medical sociology, health informatics, and social psychology; public health, emergency preparedness and response, and community resiliency; and government and public policy) to develop tools and methods for sustainable infrastructure design. With this cross-disciplinary innovation, the SSCRC provides an enabling platform to become an agent of change in public policy, to impact human interaction with the environment and to shift the paradigm of urban infrastructure to one that is economically affluent, environmentally responsible, and socially equitable.

Describing a few of the training and outreach initiatives undertaken at our university under the framework of the center is the aim of this paper. Each of the initiatives is presented in the following sections.

Youth champions – Building Our Future Today!

The Sustainable Smart Cities Youth Champions program targets middle school students attending inner-city schools for a first exposure to the concepts of sustainability. It combines hands-on learning activities with a field trip to teach some of the fundamental principles of sustainable cities. Over 4 weeks, students learn about the importance of clean air, clean drinking water, trash disposal, energy conservation, transportation, and open spaces. The goal is to teach the students to look at their daily lives and their neighborhoods in terms of natural resources and their impacts on them, a viewpoint that few of them had taken before.

Through the Sustainable Cities Youth Champions program, middle school students are exposed to new fields of knowledge as well as future career opportunities in sustainability and in the emerging "Science of Cities." Each selected middle school designates 25 to 30 students to participate in this program. The program consists of four visits to UAB scheduled on Saturdays. Each Saturday, one of the following four themes within sustainability is addressed:

1. Sustainable Transportation and Energy Conservation
    - Importance of transportation

- Active transportation (bikes, peds, and complete streets)
- Energy use, emissions, and conservation (Figure 1)

2. Environmental Health
   - Air and water quality
   - Hazardous materials
   - Indoor environments
   - Water use reduction
   - Waste minimization and recycling
3. Field Trip " Eco–Awareness"
   - During this field trip in one of the mountains of our city, students encounter the amazing diversity of the forest ecosystem. This field trip explores the interdependence of the environment, plants, and animals on a 3 mile hike. Students also participate in an environmentally focused role play activity deciding the fate of the Mountain from different points of view. This excursion lasts approximately 3 hours total, including a tour of the nature center at the mountain.
4. Health and Livability of Cities
   - Food systems/Urban gardens
   - Recreational space
   - Green buildings

Figure 1 – The students assembling a solar-powered car

During the last Saturday of the month we host a final reception where every student gets a certificate for the successful completion of the "Student Enrichment Program in Sustainability Engineering" (Figure 2).

Throughout the program students learn how to incorporate these concepts into the designs for the city of tomorrow. These principles are discussed both in global terms as well as how a student can practice them in their home and in their everyday life. Hands on experiences are emphasized. Lessons are taught by UAB's faculty, graduate students and staff.

Regarding logistics, students meet each Saturday at 8:45 am, in their respective school. They travel in a school bus to each field trip location, escorted by 2 to 4 of their school's science teachers. A light breakfast is served at 9:00 am and the activities take place from 9:30 am to 11:30 am. Lunch is provided from 11:30 am till noon. Students are picked up from the school by parent or guardian upon return from our university at 12:30 pm. It is essential to have available

the following resources to run this program:

- Classroom
- Laboratory
- School bus to pick up and drop the students off
- Faculty, grad students and staff to guide the activities
- Food for breakfast and lunch
- T-shirts for students

Figure 2 – Middle School Students after they received their certificate

As stated, our goal is to introduce fundamental sustainability concepts to the students. In order to assess the effectiveness this program, we developed a short quiz given to the students on the first day of the program and again on the last. The quiz is titled “So What Do You Know about Sustainability?” and the results are compared to gauge how well students learned the concepts presented (see Table 1). If students do poorly on a specific concept, that is reinforced in subsequent sessions. We also assess the engagement and input of the middle school students during each Saturday of the program. Overall the students had a great response to the entire program and appeared to be highly interested in the topics. We also developed the following survey for the school teachers participating in the program in order to obtain feedback and to better assess the effectiveness of the program and how we can improve in future offerings (see Table 2).

Table 1 – Student Evaluation Quiz

So What do You Know about Sustainability?

Take this short quiz to see how much you know about sustainability.

Section 1 – Multiple Choice and Short Answers

1. What is the main fuel we use to generate electricity in Alabama?
   a. Solar power
   b. Oil
   c. Coal
   d. Nuclear

2. What is the main fuel we use for transportation in Alabama?
   a. Oil
   b. Water power
   c. Solar
   d. Nuclear

3. What does sustainability mean?
   a. To keep doing what we're doing right now
   b. Using resources in a way that doesn't hurt the next generation
   c. Using whatever we can to improve our lives today
   d. Drilling for more oil so that we don't run out

4. Which of the following are examples of sustainable practices?
   a. Recycling
   b. Walking or biking
   c. Riding the bus
   d. All of these

5. What are ways we can conserve energy?
   a. Use less of it
   b. Use renewable fuels
   c. Make things more efficient
   d. All of the above

6. List 3 things you can do to use less energy at home:
   a. _____
   b. _____
   c. _____

7. Name something you can do at home to make it more energy efficient:

8. Which one of the following is <u>not</u> a renewable energy source?
   a. Solar power
   b. Natural gas
   c. Wind Power
   d. Water power

9. How much "Trash" does the average American produce in a day?
   a. 0.4 pounds
   b. 40 pounds
   c. 4.0 pounds
   d. 400 Pounds

10. Which one of the following is not a "Water Pollutant"?
   a. Rainwater
   b. Oil
   c. Fertilizer
   d. Dirt

Section 2 - True / False

Mark the following statements True or False

11. _____ The city of Boston, MA sits on top of an old trash dump.

12. _____ We can stop all forms of air pollution with technology and government regulations.

13. _____ Nature can produce air pollution that is harmful to people and the environment.

14. _____ Rivers and lakes within the United States are clean and suitable for drinking.

15. _____ The most difficult sources of water pollution to control in the environment come from industrial pipes.

16. _____ A bus produces less pollution per passenger than a car.

17. _____ Solar power by itself can power a car.

18. _____ Kids can't really do much to conserve energy because they don't pay the bills.

19. _____ Nuclear power pollutes the environment.

20. _____ Compact florescent (CF) light bulbs use less energy than traditional bulbs

Table 2 – Teachers' survey

YOUTH CHAMPIONS – TEACHERS SURVEY	
1.	Do you think the students grasped the concepts of what was being taught? Was the material presented appropriate to the age of the students?
2.	Were the hands on experience beneficial?
3.	Was the time schedule reasonable?
4.	Do you suggest any improvements to the technical content of the program?
5.	Do you suggest any improvements to the program logistics?

In addition, there has been lessons learned that we intend to implement in future offerings. For example, one lesson learned is to involve the families of the middle school students during one of the four Saturday meetings. We believe that this program will have a greater impact if the students participate together with their families in some of the learning experiences regarding the importance of taking an active role in the environment to promote a sustainable future. Ideally the parents would also attend during the last Saturday of the program when we host the final reception and hand every student the certificate for the successful completion of the program. Another lesson learned is to follow up with the school teachers after the program has taken place to obtain additional information regarding the level of interest shown by the students in the sustainability topics discussed during the duration of the program.

Summer Enrichment Program

The Summer Enrichment Program is an educational agenda lasting one month during the summer. Participants in the program are current and incoming minority freshmen students enrolled in historically black colleges and have an interest in engineering and transportation related careers. The goal of the program is to increase the number of competent, well trained minority engineers, researchers, and transportation professionals working on sustainable transportation issues of importance to our region and the nation. The program is in partnership with UAB's Minority Health and Health Disparities Research Center, which is a comprehensive education research and community outreach center focused on eliminating the health disparities of racial/ethnic minorities.

The program has many financial benefits to help encourage participation. The students receive a weekly stipend as if they were working for an employer, or replace monies that they would otherwise gain during summer work. This has found to increase the interest of parents to promote participation. It also gives the students a level of accountability: They know their participation in all program activities are required for payment. The students also receive free room and board at the university dormitories. This is particularly exciting for incoming freshmen students and provides experience of college life prior to beginning their academic career.

Activities of the program are abundant and keep the students busy during their month-long participation. A major component of the program is the STEM related coursework. Students take courses in Scientific Writing, Cultural Competency and Career Roadmaps that require additional homework and research. The Scientific Writing course discusses the process of writing in a scientific manner, and how to effectively compose scientific school reports and abstracts. This prepares them for the rigors of academic assignments, and gives them a strong advantage over other students. The Cultural Competency course discusses health and transportation engineering issues facing other countries. The students perform research on the issues, advantages, and designs used by countries of their choice other than the United States. It gives the students a broader global perspective of the world that is invaluable to the education of any person. The Career Roadmaps course forces students to lay out a four year strategic plan as a college student. The students prepare a poster that outlines their individual roadmap needed to obtain a college degree in engineering, and the licensure required for professional work.

The students attend technical seminars presented by industry professionals and faculty on a variety of STEM disciplines (Figure 3). The seminar agenda is designed to illustrate the relationship between engineering of the built environment and public health. Many topics are covered such as green building design, disciplines of civil engineering (i.e., structural, transportation, and environmental), sustainability and lighting energy conservation, solar panel technology, career development in engineering, social impacts of nutrition, impact of food deserts on public health, and environmental justice. Students enjoy this activity of the program, and participate in lengthy discussions that are often times inspired by their own ideas and concerns. In addition to the professional and faculty led seminars, the students attend the annual UAB Sustainable Smart Cities Symposium that occurs during the month of the program. The symposium includes presentations by expert speakers and researchers in the field of smart cities and sustainability. Students experience research on a high level, which rallies their inner drive to actively participate in the engineering community.

Figure 3 – Students during faculty presentations

Important to the program is the ability to effectively work in a team environment. One of the activities conducted in the program is to teach students teambuilding skills and participate in undertakings that require a team to complete. A presentation on Tuckman's four stages of team development is given to students, followed by activities that accentuate each stage. This presentation is scheduled at the beginning of the program to help students interact and get to know each other. They can carry these lessons with them throughout their student career as well as into their engineering profession.

One of the most influential activities in the Summer Enrichment Program are the research projects. The students are divided into groups and use their team development skills and complete a STEM related research objective that is led by faculty. Research projects fall under the sustainability and public health theme of the program. Examples of projects include the effectiveness of tower gardens, autonomous vehicles, fuel cell technology, green buildings, and alternative energy. At the end of the program, students prepare a poster on their findings using lessons from their Scientific Writing course. The posters are presented by the students during the closing ceremony. First, second and third place prizes are awarded based on their presentation, how the research was carried out, and their application of scientific writing principles.

One of the more entertaining activities in the program are the tours of the university facilities. The students tour the university laboratories (Figure 4) and see—first-hand—some of the research testing conducted by faculty and graduate students. They learn about laboratory safety and participate and case studies that addresses ethical issues with research and professional practice. The students also take tours of the green roofs constructed on campus where they learn the basic construction process of the green roof, its function, types of plants, and energy savings of the building. A tour of the university library is also provided, in which proper literature review processes are introduced and how to effectively use databases.

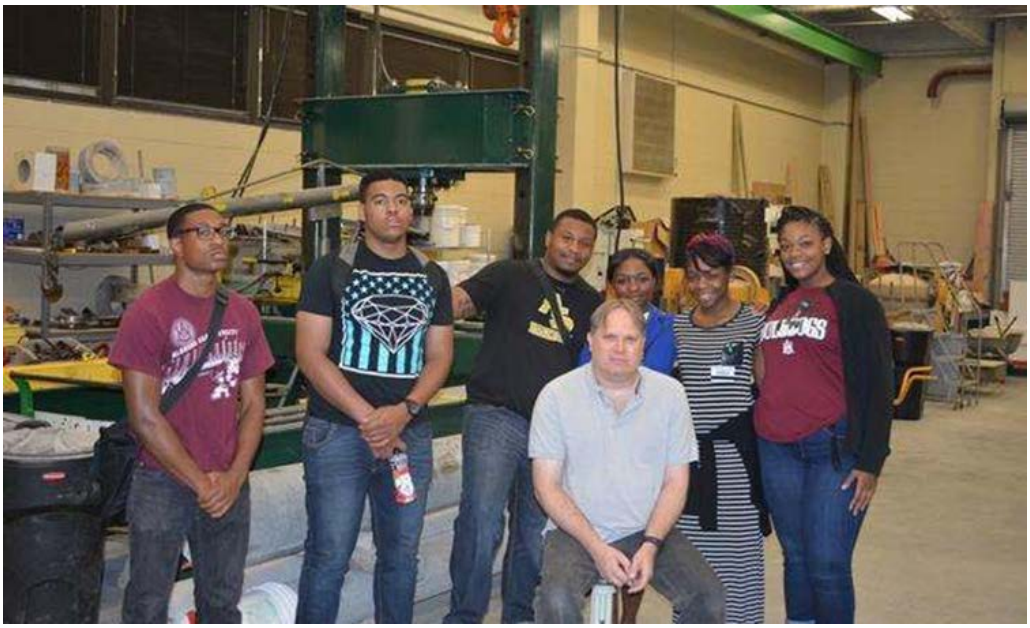

Figure 4 – Laboratory tours

The Summer Enrichment Program has been offered during the past three summers. Enrollment has steadily increased with each offering. Students are asked to provide a testimonial at the end of the program describing their experiences, what they learned, which activity had the most impact, and their plan for the future. Example statements that stand-out include:

"I learned the ethics of engineering and the proper way to gain knowledge in order to formulate a thesis;"

"I learned so many things that can help me become a better person in college and in life;"

"Without this beneficial program, I would not have a sound foundation to build onto as I transition into college."

Students leave the program with a broader global perspective, with team building skills as well as with an extensive understanding of what sustainability is and its importance. The main goal of the initiative is to increase the number of competent, well trained minority engineers, researchers, and transportation professionals working on transportation issues from a sustainability standpoint. In order to assess the success of the program we periodically connect with the students to follow up their progress and to know the percentage of students that continue to be interested in pursuing a transportation engineering career from sustainability perspective.

Past students that participated in the program are now entering sophomore and junior level classes, with a 50 % enrolled in engineering at the university that hosted the program. They are completing professional level assignments and show a strong drive and understanding of the purpose of the coursework. We are now in the process of developing further activities to implement in future program offerings in order to increment the number of students that pursue a transportation engineering degree posterior to their participation in this program.

NSF International Research Experience for Students

Many of the world's most pressing science and engineering challenges are trans-national in nature and some of the leading scientific and engineering facilities, resources, and expertise are found outside the United States. Moreover, many of the great opportunities in the sustainability field are located abroad. In order to remain at the forefront of science, technology, engineering, and mathematics (STEM), the United States needs to nurture a globally-engaged STEM workforce capable of performing in an international research environment.

To help address this need, the NSF International Research Experiences for Students (IRES) program supports development of globally-engaged U.S. science and engineering students capable of performing in an international research environment. IRES projects involve students in meaningful ways in ongoing research programs or in research projects specifically designed for the IRES program. Such experiences expose U.S. students to the international research community at a critical early stage in their careers.

Eight undergraduate and graduate students participated in this program during the past summer of 2015.(Figure 5) This program spanned four weeks, with the first two weeks spent in the Netherlands and the following two weeks in Egypt, providing the students a unique learning opportunity. Spending the first two weeks of the program in the Netherlands, a country that has some of the most sustainable and smart cities in the world, provided the students with a much broader view of what sustainability and sustainable construction can mean in a mature environment. The two weeks spent in Egypt exposed the students to sustainability efforts in a developing country, where goals and priorities can be very different. The students benefited from experiencing, learning, and contrasting sustainability efforts in the two countries. The students benefited as well from being exposed to both the Middle Eastern and European cultures.

This program stimulates students to examine sustainability from different perspectives and consider how different countries and cultures address technical, environmental, and social challenges in order to create sustainable solutions. The students applied the knowledge gained from the Netherlands experience to the research, training, and education that took place in the second part of the program in Egypt.

Figure 5 – Students participants in the NSF International Research Experience (Summer 2015)

Even though the international experience lasted four weeks, the entire program encompassed a period of several months. Students took what they learned during their trip and applied it to research projects they undertook with mentors from either the Netherlands or Egypt. A team

formed by UAB's faculty and staff met with the selected students on several occasions before and after the international experience. During the meetings prior to the trip the faculty and staff helped the students prepare for the trip and to make the most out of their experience. The students were assigned specific projects and started researching and collecting information that was beneficial during their trip. After the trip, the faculty and staff met with the students to help them prepare their reports and presentations, as well as to get feedback from the students and evaluate their experience.

For the 2015 trip, the core research theme focused on the multidisciplinary area of sustainable green building design and construction. This was selected for three primary reasons: 1) with the rising costs of energy, there is a growing need for energy conservation and protecting the natural resources by using environmentally friendly and energy- efficient building materials; 2) the area is broad and encompasses a number of research areas, thus providing a unifying research theme that would enable an interrelated research experience for the U.S. students; and 3) our university and the host institution in Egypt have collaborated on research projects in this area and have jointly held two NSF International Workshops directly related to this theme.

Students in the program were involved in collaborative research projects with direct mentoring by faculty from the U.S. and Egypt, as well as experts on sustainability from the Netherlands (Figures 6 and 7). The following research projects were undertaken by the students:

- Green Wall Applications: Toshka, Egypt
- Building Envelope Systems around the World
- Strength Performance of Recycled Aggregate Concrete with Class C Fly Ash
- Green Building Codes in Egypt

The students spent from April 26th to May 10th in The Netherlands. During these two weeks the students visited diverse sustainability sites and met with sustainability experts. Apart from the research working sessions, some of the activities that took place during these two weeks included:

- A bike tour of Amsterdam and visit to Westergasfabriek to learn about the clean-up of a heavily polluted industrial site and its transformation into a vibrant cultural center.
- A tour of North Amsterdam, including a visit to De Ceuvel, the urban gardens, and student container housing
- A visit to the Van Gogh Museum and Stadhuis
- A tour of the University of Amsterdam to learn about their graduate program in Science for Energy and Sustainability
- Sightseeing by bike in Gouda to study sustainable food production and buildings constructed from natural materials in the area
- A walking tour of water containment structures and a comparison to similar structures on the Alabama Gulf Coast
- A tour of green roof sites and an electric car charging grid
- A lecture at the Technical University campus and a tour of the impressive library recently constructed using sustainable architecture
- A discussion with Technical University faculty about sustainable agriculture practices and local markets for produce

Figure 6 - The students in the Netherlands

Figure 7 - The students in Egypt

On May 10th the students travelled from the Netherlands to Egypt. During their two weeks in Egypt, the students were assigned mentors from the partner institution in Cairo. The mentors were expert faculty conducting research in different areas of sustainability. The faculty guided and helped the students with their specific projects at the same time they trained them in other sustainability topics specific to Egypt, such as green building code development in Egypt and the new capital to be developed as a smart city. Other activities that took place during the two weeks included:

- Attended an NSF International Workshop that was in fact developed by one of the faculty at our University. The topic of the Workshop was: "Sustainable Infrastructure in Egypt: Air and Water"
- A visit to the American University in Cairo (AUC) in which the students toured laboratories, facilities, and met with faculty and students. Also included was a visit to the site of a green building under construction
- A sight-seeing trip to Ain Sokhna by the Red Sea
- A visit to the Egyptian Museum and the Great Pyramids of Giza
- A visit to the laboratories of our partner institution in Cairo
- Multiple meetings with industry people or managers of related sustainable projects

This NSF program covered all the expenses related to the International Research Experience, including round trip airfare, accommodations, transportation and supplies. Our University provided the faculty and staff necessary to make this program successful.

Overall, the first year of this NSF International Research Experience for students has been an accomplishment for UAB. The students gained valuable research experience in the area of sustainability at the same time that they acquired a global perspective by being exposed to engineering norms and practices in different countries and cultures. In order to assess the success of this program we evaluated their research reports, their oral presentations, as well as their interaction and involvement during the length of the program. Faculty mentors from our university as well as from the partnering international institutions were directly involved in the assessments. We also collected several surveys from the students and a summary of their experience. In addition, we have encouraged the students to continue working on their research projects and to apply to present their experiences and findings at different sustainability conferences and workshops. So far, two of the students have submitted their abstract to two different conferences and they have been accepted.

Sustainable Smart Cities Master Program

The new Sustainable Smart Cities Master's program from UAB is in collaboration with a partner institution Staffordshire University from the United Kingdom (UK). This is a unique fully online professional postgraduate program that provides an inter-disciplinary grounding in the principles, application and key technologies required to develop sustainable smart cities.

The Master's program in sustainable smart cities originated from a mutual to develop a more interdisciplinary education to face the emerging challenges of cities and the continuous growth of population is having and will continue to have an effect on how cities are develop and how they operate.

We are living in the century of the city and for the first time in human history more than half of the world's population now lives in a metro area and the urban population is set to double by 2050. Cities are the engines of economic growth, innovation, education and culture, but they are also home to concentrations of poverty, social exclusion and environmental degradation and are responsible for 80% of the World's CO_2 output. Despite these challenges, cities are increasingly seen as the centers of sustainable development and the shift to a low carbon economy. Rapid technological developments present unprecedented opportunities for cities to design and adapt into smart, intelligent and sustainable environments through digital technologies, big data, low-energy buildings and neighborhoods, renewable energy and smart mobility. The opportunities created by these new technologies challenge the way in which we conceive of cities, how we design and construct them and how we will ultimately live in them.

Creating a sustainable smart city requires cross-sectoral and inter-disciplinary approaches to develop new political, financial, social and cultural models afforded by new technologies and systems. There was never a more exciting time to be involved in the design and development of cities. The goal of the Master's Degree in Sustainable Smart Cities is to equip the students with the knowledge and skills necessary to help transition the sustainable smart cities of the future.

The Master's Program is delivered by experienced faculty at UAB and at our partner institution Staffordshire University. This genuinely international program will equip our student with the knowledge, skills and critical thinking to assess, design and implement sustainable smart cities strategies across the globe. The program offers a broad curriculum covering sustainability theory, sustainable urban development, low carbon and renewable energy systems, green infrastructure, natural resource management, health and livability, transport and mobility, big data analytics and smart technologies.

This program is aimed at leaders and working professionals in public and private sector organizations who seek to design, develop, and deliver smart and sustainable urban solutions. It will be suitable for senior executives, elected representatives, policy makers, engineers, urban planners, architects, real estate professionals, software programmers, ICT professionals, public health and social medicine professionals, environmental and sustainability managers among others. This award is particularly suitable for graduates who have been working for a number of years and are looking to take the next step in their career, or professionals seeking a change of direction.

The Master's in Sustainable Smart Cities is delivered via the following ten modules:

1. Principles of Sustainable Development
2. Introduction to Sustainable Smart Cities
3. Low Carbon and Renewable Energy Systems
4. Managing Natural Resources and Sustainable Smart Cities
5. Green Infrastructure and Transportation
6. Green Buildings
7. Health & Livability
8. Smart Technologies for Cities & Buildings
9. Big Data & Smart Cities
10. Research Methods & Project Planning

Capstone Research Project– during the capstone research project the students will design and implement a piece of research that will enable them to reflect on the knowledge and skills which they have learned during the taught modules and apply them to a real world problem or issue. This research may draw on the practical and work-related experiences of the student. The students will have an opportunity to present their capstone project findings at the annual UAB Sustainable Smart Cities Research Symposium hosted by the SSCRC.

This program will be launched during this upcoming summer semester 2016, therefore we do not have any assessment data available to analyze the effectiveness of this master's program. However, the main indicators that we will take into consideration in order to assess the success of the program will be based on the placement of the students post completion of the master's, the program's enrollment growth, and feedback obtained from alumni surveys as well as from our university IDEA surveys.

Interactions between the UAB and the City of Birmingham

UAB, being an urban university, has established a strong partnership with the City of Birmingham and specifically, the SSCRC has signed a memorandum of understanding (MOU) with the City to partner on projects such as energy efficiency and city planning that accounts for a more livable city.

This liaison with the City of Birmingham has provided students with the opportunity to participate in major initiatives toward smarter, healthier and more sustainable development of our City. Several students have contributed with faculty in conducting research and providing support to develop and improve these projects. The following are some of the main and most successful initiatives that the SSCRC has worked with the city in the past years:

- IBM Smarter Cities Challenge – The City of Birmingham was selected to receive the Smarter Cities Challenge grant which contributes the skills and expertise of IBM top talent to help the city address its critical issues.
- Ecodistricts – The City of Birmingham was selected, among 12 cities in the U.S. to participate in this project-based workshop designed to accelerate district-scale sustainability across North America
- Bikeshare system – Recently, the City of Birmingham launched a bike share system that includes electric pedelec bicycles. We are exploring research opportunities around the health, safety and environmental impact of this bikeshare system in the city.

Conclusion and Summary

The effects of globalization have been far-reaching and are present in our daily lives. Yet, globalization presents a potential threat to our environment and, hence, a threat to the future of our civilization. This situation creates a need for a change in education in order to develop a workforce of engineers capable of confronting the challenges of the present and the future. A global education is required to give the students a broader perspective of the world and its needs, but more important, there is an imperative need for sustainability education to be introduced in all aspects of engineering education.

This paper describes the education initiatives that UAB is undertaking through its Sustainable Smart Cities Research Center in order to develop a strong workforce of engineers in the area of sustainability, and in the context of globalization, that have the knowledge and capability to make decisions that will improve the state of ecosystems, the economy and the health and well-being of human race on the planet.

The assessment of the sustainability programs undertaken at UAB have provided useful information and ideas for enhancing future offerings. By constantly improving these programs, we will be able to offer unique learning experiences to our present and future students that better prepares them for practice in a global environment with a solid understanding of sustainability and its importance to engineers in facing future challenges.

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