

Enhancing University STEM Students' Understanding of Sustainability Through an
International Experience in Bucaramanga, Colombia

Sandra A. Labby, Ed.D.

Texas A&M University - Texarkana

Abstract

Sustainability of natural resources involves the endurance and processes of diverse biological systems and the protection of those systems (James, Magee, Scerri, & Steger, 2015). The 2005 World Summit on Social Development identified three interconnected goals of sustainability: environmental protection, social development, and economic development (United Nations General Assembly, 2005). Unfortunately, humans have negatively impacted numerous ecosystems globally, and thus, the survival of humans and other organisms.

Quite often, university students are naïve to economic, social, and biological issues of protecting, harnessing, and/or maintaining sustainable resources. Students do not have the experiences to understand the complex nature such concerns pose to the quality of life in the United States and in other countries.

Through the joint collaboration of Texas A&M University-Texarkana and La Universidad Autónoma de Bucaramanga, Colombia, several biology and engineering students from A&M – Texarkana were immersed in the culture of Bucaramanga in an effort to create environmental, social, and economic awareness of that city's efforts related to soil erosion, water conservation, and energy production issues. Students from both universities presented their understandings of these issues to students in a local public school in Bucaramanga. The purpose of this case study was to determine if the development of a parallel course design was indeed replicable and, to assess the value of an international partnership experience for university Science, Technology, Engineering, and Mathematics (STEM) students while developing their awareness and understandings of global issues related to sustainable resources.

The results of the experience included gaining a deeper understanding of the interconnectedness of the sustainability goals in Bucaramanga, Colombia, and building a university partnership to enrich the international educational opportunities for the STEM students.

Enhancing University STEM Students' Understanding of Sustainability Through an International Experience in Bucaramanga, Colombia

University Science, Technology, Engineering, and Math (STEM) students may be deprived of hands-on experiences that connect scientific concepts, principles, and theories presented in their textbooks, laboratory experiences, and university courses to real-world contexts in countries other than the United States. These same students may lack the global awareness that various environmental, social and economic issues are as equally pervasive in other countries as those same concerns are in the United States. To foster a deeper understanding of the environmental issues of soil erosion, water conservation, and energy production, which are of global concern, collaboration between international university partners, to create a replicable model, may provide a rich scientific and cultural experience for university students.

Review of the Literature

Sustainability, A Global Effort

Sustainability has been defined as the endurance and processes of diverse biological systems, with respect to natural resources, and the protection of those systems. Sustainability has also encompassed the balancing of local and global efforts to meet basic human needs without destroying or degrading the natural environment (EurActive, 2004; Kates, Parris, & Leiserowitz, 2005; International Institute for Sustainable Development, 2009;). The 2005 World Summit on Social Development identified 3 interconnected goals of sustainability: environmental, economic, and social goals. The Summit's efforts identified three additional common characteristics (bearable, viable, and

equitable) that further demonstrated the interconnectedness of the primary goals (Adam, 2006).

In a working-draft of a technical report by the Bureau of the United Nations Statistical Commission (UNSC) on the development of an indicator framework for the goals and targets of the post-2015 development agenda, the Commission identified 17 sustainable development goals. The goals included were: 1) no poverty; 2) zero hunger; 3) good health and well being; 4) quality education; 5) gender equity; 6) clean water and sanitation; 7) affordable and clean energy; 8) decent work and economic growth; 9) industry, innovation and infrastructure; 10) reduced inequalities; 11) sustainable cities and communities; 12) responsible consumption, production; 13) climate action; 14) life below water; 15) life on land; 16) peace, justice, and strong institutions; and, 17) partnerships for the goals (United Nations Statistical Commission, March 2015). These goals have since become the framework for the development of sustainability initiatives worldwide.

Sustainability in Bucaramanga, Colombia

In 2012, the city of Bucaramanga, Colombia, committed to the Emerging and Sustainable Cities Initiative (Inter-American Development Bank, 2015). To maximize the impact of improving the quality of life and sustainable resources, strategic partnerships were developed within the city of Bucaramanga to strategically improve the environment, economic growth, and social well-being of the city. The city of Bucaramanga partnered with the Colombian National Development Bank, Findeter, to form the *Platform for Sustainable and Competitive Cities (CSC)*. Bucaramanga, together with three other cities, Barranquilla, Manizales, and Pereira, developed actions plans with

actionable priorities for which financial investments were then allocated. Action items included: adaptation, climate change, education and health, energy, fiscal management, information technology, infrastructure, public transportation, resiliency, safety, urban development, water and sanitation. Since 2012, several other large cities in Colombia have joined the CSC to prioritize their efforts toward sustainability and obtain funding to support implementation of their actionable programs (Inter-American Development Bank, 2015).

University Study Abroad and International Partnerships

Immersion of university students in an international cultural exchange broadens students' depth of knowledge regarding global issues and cultural awareness. According to statistics from the Institute for International Education (2014), STEM fields (23%) lead the disciplines of American study abroad programs. This is followed by "social sciences (22%), business (20%), humanities (10%) and fine or applied arts (8%)" (Goldoni, 2015, p. 2). The context of such programs is usually short-term immersion into the culture and thus, minimal engagement within the communities being visited. Typically, large groups of undergraduate students from the United States travel together, take the same classes, and are taught by home and host university faculty who are familiar with the framework of the United States educational system. The programs present organized activities, both educational and social, to maximize the international experiences and do not lend themselves to total immersion within the culture (Isabelli-Garcia, 2006). Additionally, many programs consider English to be the globally accepted official language and do not foster a multilingual approach within the international experience (Kubota, 2002).

As seen in the statistics from the Institute for International Education (2014), STEM programs and faculty have encouraged their students to actively participate in study abroad programs. Such experiences have presented STEM students a global awareness of opportunities within the scientific workforce (Thao, Lawrenz, Brakke, Sherman, & Matute, 2016). Additionally, through building effective relationships with university partnerships and purposefully including cross-cultural understandings (Pierson, Myck-Wayne, Stang, & Basinska, 2015) into course designs, students were exposed to common international issues, including environmental awareness and sustainability. Educational partnerships have the opportunity to bridge the gap between theory and practice by offering students the practical knowledge, abilities, and skills to address the needs of society and industry (Daniels, M., 2015).

Methodology

This research was a case study (Gall, Gall, & Borg, 2007) focused on university STEM students' awareness of environmental issues through a parallel course design through two universities' partnership. Qualitative data was collected through active participation in the cultural immersion study abroad, observations with respect to environmental issues, interviews with students, and development of a replicable model for future partnerships.

Texas A&M University – Texarkana and La Universidad Autónoma de Bucaramanga (UNAB), Colombia partnered on a grant endeavor through *100,000 Strong in the Americas* in which the two universities collaborated to create a replicable model for a joint partnership between universities. The focus of the collaboration was two fold: 1) to develop parallel course delivery for environmental awareness with respect to

sustainability, and 2) to immerse students in each other's cultures through study abroad student exchanges. There were three phases to the grant.

The first phase involved the co-development of an environmental studies course at both universities with common student learning outcomes. The curriculum design transferred from the university classroom setting to the educational community of school-aged children. The parallel course development and delivery offered opportunities for highly engaged professional collegiality and motivation among university faculty for active student participation.

The second phase engaged the university students in collaborative activities in each university's hometown. The Colombian students traveled to Texarkana, Texas. In Texarkana, an educational pavilion with teaching stations was created in a local park for community's elementary school children. The students from both universities invited several grade levels of elementary students to actively participate in environmental activities related to sustainability. In Bucaramanga, Colombia, the educational endeavor extended into a middle school and a high school through an environmental fair facilitated by the university students from both Texarkana and Bucaramanga. The goal was to actively engage middle school and high school students in global issues related to sustainability.

The third phase involved the university students' international study abroad experiences. The STEM students, from both Texas A&M – Texarkana and UNAB, enrolled in the parallel courses at their respective universities. Intensive language classes with targeted vocabulary were taken by both groups of students. Specific and specialized

cultural experiences related to sustainability were part of the global awareness education of the university STEM students.

The results and discussion for this research project focused on the third phase for the Texas A&M – Texarkana students and their international experiences in Bucaramanga, Colombia, as related to sustainability. The city of Bucaramanga’s efforts related to environmental, economic, and social awareness included soil erosion, water conservation, and energy production. Replicable aspects of the parallel course design were presented here, as well.

Results and Discussion

Through the university partnership between Texas A&M University – Texarkana and La Universida Autónoma de Bucaramanga, the students experienced first-hand environmental management of land use and freshwater, the development of alternative energy resources, and social progress in the city of Bucaramanga.

Environmental Dimension

The students from Texas A&M – Texarkana visited several erosion sites to witness the effects of soil erosion due to seasonal rains, seismic activity, urbanization and population growth in Bucaramanga. The environmental management of the land required stabilization of land next to major highways and beneath hillside homes. Land stabilization along highways was accomplished through the installation of coated wire mesh that was anchored at the top of the hillsides and then unfurled as it lay on the side of the hill. Native vegetation, such as grasses, was planted in the soil to further stabilize the ground from further erosion. The lands beneath hillside homes were stabilized through the use of four-inch layers of sprayed concrete. Pipes were drilled into the hill to

reduce hydrostatic pressure from rain runoff; thus, providing a means for the water to drain through the soil, without producing further erosion or deterioration of the land. Only habitable sites were funded using the sprayed concrete procedures. These initiatives supported the United Nation's sustainability goals of decent work and economic growth; industry, innovation, and infrastructure; climate action; sustainability; and, life on land (United Nations Statistical Commission, March 2015).

A visit to the Matanza Dam – Acueducto de Bucaramanga permitted the students to see first-hand the construction of a dam and reservoir that was designed to retain water from the rainy season. The purpose of the dam was to provide the city of Bucaramanga with a water source until approximately 2050, based on current population trends. The city of Bucaramanga is located in the foothills of the Andes Mountains with no major river providing fresh water to the entire city. The dam's location was purposefully selected between two adjacent mountains. Rock from the excavation of both mountains was used in the construction of the dam; thus, using the available natural resources became a means to defray additional construction expenses. The city's responsiveness to meeting the needs of its people was truly aligned with several of the sustainability goals of the United Nations including zero hunger; good health and well being; clean water; industry, innovation, and infrastructure; sustainability; and responsible consumption, production (United Nations Statistical Commission, March 2015).

Economic Dimension

Economic growth corresponds to increasing pressures on the environment. According to the International Resource Panel, hosted by the United Nations Environment Program (UNEP) – 2011, by 2050, 140 billion tons of biomass, fossil fuels, minerals, and ores per year could be used up by the human race. This is three times the current rate of consumption. Developed countries use approximately 16 ton/per capita/year, while underdeveloped countries use approximately 4 tons/per capita/year (United Nations Environmental Program, 2011). The need for alternative sources of energy is quite evident based on these estimates. The students from Texas A&M – Texarkana had the opportunity to visit the research laboratories and engineering facilities of La Universidad Autónoma de Bucaramanga (UNAB). The students enrolled in the Energy Engineering Program at UNAB were not only learning about alternative energy sources, but were trying to create more efficient wind, solar, and hydro-energy resources. The United Nations sustainability goals of providing quality education and industry, innovation and infrastructure were being addressed (United Nations Statistical Commission, March 2015).

Social Dimension

Social growth was measured using the Social Progress Index (SPI) framework. The SPI is a holistic measure of a country's performance, measuring everything from personal safety to health and wellness to sustainability. It is not based on wealth or economic indicators (Porter & Stern, 2015). A formalized operational definition social progress is:

the capacity of a society to meet the basic human needs of citizens,

establish the building blocks that allow citizens and communities to enhance and sustain the quality of their lives, and create the conditions for all individuals to reach their full potential (Porter, 2016, para. 1)

Regarding social growth, one small, inexpensive, and easily achievable step that may have the greatest impact on the environment, meeting the basic needs of the populace, sustaining quality of life, and helping people reach their full potential is through the education of a nation's youth and the communities in which they live. Such was the case for the students from Texas A&M University-Texarkana and La Universidad Autónoma de Bucaramanga, Colombia, together, they presented an Environmental Fair at Colegio Panamericano. The university students created hands-on, engaging activities for the middle school and high school students in attendance. Universal issues of global warming, recycling, and clean energy were presented. To further open the minds of the students at Colegio Panamericano, the principal of the school asked the university students to share what their intended career paths were, what college life was like in the United States and Colombia, and their changed perspectives of Colombia based on this international exchange and experience.

One of the students shared the following:

I learned that the sustainable resources in Bucaramanga were a concern of the city because they want to find renewable energy alternatives. My impression of the environmental concerns in Bucaramanga were first and foremost the land erosion. It was caused by the natural erosion of rain and wind. I experienced an inside view of higher education in a different country. My educational

highlights were when we went to see different erosion sites throughout the city, and one of them was in the back yard of a row of apartments.

Another student shared:

The most fascinating aspect of the trip was seeing the already implemented techniques for sustainability in the city of Bucaramanga (for instance the cement stabilized mountain side in an effort to prevent erosion). The students had an overwhelming passion for renewable and pollution-free energy sources which was very evident in both their intelligence of the subject as well as the experiments being conducted. What a cultural experience it was to see the differences between the Colombian way of life/education compared to ours here in the U.S. Since returning from the trip, I have noticed a profound thankfulness for the opportunities I so often would have taken for granted. Such a life-changing experience it was, to visit such a beautiful and hospitable country and to develop life-long friendships with the amazing students at La Universidad Autónoma de Bucaramanga.

While the university partnerships between Texas A&M University-Texarkana and La Universida Autónoma de Bucaramanga were initiated through the *100,000 Strong in the Americas* grant process, the success of the parallel course design provided the students with the opportunity to participate in a replicable model for international study. The content of this experience was environmental awareness and sustainability. The commitment of the university faculty was evident through discussions regarding future parallel course development and the potential for dual degree offerings.

Conclusion and Implications

The opportunity for STEM students to participate in the *100,000 Strong in the Americas* collaboration between Texas A&M University-Texarkana and La Universidad Autónoma de Bucaramanga, Colombia, was a rich and rewarding experience for both groups of students, for those from Bucaramanga, Colombia and those from Texarkana, Texas. The parallel course design created by the partnering universities raised environmental awareness regarding land use, acquisition of fresh water, and developing alternative sources of energy. Having the students travel to each other's countries further engaged the students in deepening their understanding of sustainability as a global issue. The cultural immersion reinforced providing collaborative educational opportunities for university students to maximize the impact of education on the youth and communities from both cultures. The partnering universities were successful in their endeavor to create a replicable model for future projects and student exchanges. Collaboration between and among university professors should and will continue as the opportunities are limitless for our students.

Future research should include case study findings from other university partnerships with respect to the parallel design of courses with common student learning outcomes. Studies regarding the extent to which faculty relationships fostered through the study abroad programs led to collaboration on research projects should be investigated. Additionally, the long-term impact on students who participated in the study abroad programs and their career paths should be studied to determine if the global

experiences led to international jobs. Follow-up studies should be conducted to determine the extent to which the international goals of sustainability with respect to environmental management, economic growth, and social progress have been attained.

References

- Adams, W.M. (2006). The future of sustainability: re-thinking environment and development in the twenty-first century. The World Conservation Union. Report of the IUCN Renowned Thinkers meeting, 29-31, January 2006. Retrieved from http://cmsdata.iucn.org/downloads/iucn_future_of_sustainability.pdf
- Daniels, M. (2015). Collaborative technologies in global engineering: New competencies and challenges. *International Journal of Engineering Education*, 31(1), 267-281.
- EurActive. (2004). Enlargement 2004: Environment policy implications. Retrieved from <http://www.euractiv.com/section/science-policymaking/opinion/enlargement-2004-environment-policy-implications/>
- Gall, M.D., Gall, J.P., & Borg, W. R. (2007). *Educational research: An introduction* (8th ed.). Pearson.
- Goldoni, F. (2015). Preparing students for studying abroad. *Journal of the Scholarship of Teaching and Learning*, 15(4), 1-20. Doi: 10.14434/josotl.v15i4.13640
- Institute for International Education. (2014). *Open doors report 2014*. Retrieved from <http://iie.org/opendoors>.
- Inter-American Development Bank. (2015). Working together for greater urban sustainability in Colombia. Retrieved from <http://www.iadb.org/en/topics/emerging-and-sustainable-cities/working-together-for-greater-urban-sustainability-in-colombia,9683.html>

- International Institute for Sustainable Development. (2009) *Sustaining excellence: 2008/09 Annual report*. Winnipeg, Manitoba: International Institute for Sustainable Development
- Isabelli-Garcia, C. (2006). Study abroad social networks, motivation and attitudes: Implications for second language acquisition. In M.A. Dufon & E. Churchill (Eds.), *Language learners in study abroad contexts* (pp. 231-258). Buffalo: Multilingual Matters.
- James, P., Magee, L, Scerri, A, & Steger, M.B. (2015). *Urban Sustainability in Theory and Practice*. London: Routledge.
- Kates, Parris, & Leiserowitz. (2005). What is sustainable development? *Environment* 47(3), 8-21.
- Kubota, R. (2002). The impact of globalization on language teaching in Japan. In D. Block & D. Cameron (Eds.), *Globalization and language teaching* (pp. 13-28). New York: Routledge.
- Pierson, M.R., Myck-Wayne, J., Stang, K.K., & Basinska, A. (2015). Sustaining an international partnership: An evolving collaboration. *Journal of International Special Needs Education*, 18(1), 12-17.
- Porter, M.E. (2016). Social progress index. Retrieved from <http://www.isc.hbs.edu/research-areas/pages/social-progress-index.aspx>
- Porter, M.E., Stern, S., Green, M. (2015). Social progress index 2015: Executive summary. Retrieved from www2.deloitte.com/.../social-progress-imperative-index.html

Thao, M., F. Lawrenz, M. Brakke, J. Sherman, & M. Matute. (2016). Insights into implementing research collaborations between research-intensive universities and minority-serving institutions. *Natural Sciences Education*, 45.
doi:10.4195/nse2015.0025

United Nations Environmental Program. (2011). Decoupling: Natural resource use and environmental impacts of economic growth (<http://www.unep.org/resourcepanel/>). International Resource Panel Report, 2011.

United Nations General Assembly. (2005). 2005 World Summit Outcome, Resolution A/60/1, adopted by the General Assembly on September 15, 2005.
<http://unpan1.un.org/intradoc/groups/public/documents/UN/UNPAN021752.pdf>

United Nations Statistical Commission. (2015). UN Statistical Commission Agrees on SDG Indicator Framework as “Practical Starting Point.” Retrieved from <http://sd.iisd.org/news/un-statistical-commission-agrees-on-sdg-indicator-framework-as-practical-starting-point/>