

Authentic International Research Experience: Program Model in Cartagena, Colombia

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Abstract

Integrating an International Experience in Undergraduate Education is increasingly seen as an important component of high impact undergraduate activities. These usually take the form of student exchanges, internships, service learning experiences and short-term faculty led study abroad programs. Students in these programs have a very wide range of international exposure and local interaction. Despite increases in the number of American students going abroad to study, the participation by underrepresented minorities and persons in the STEM disciplines is still relatively low. The model was designed to incorporate Spanish language, culture, research, and service learning in primarily Afro-Colombian communities. Research focused on environmental monitoring using GIS/GPS tools in Cartagena, Colombia. The students were taught basic research skills such as literature review, report writing, data analysis, poster presentation, field sampling, and time management. The original model (from Cartagena) was piloted for two years and then tested in two other locations in South America. Overall the students thought the program was beneficial to their professional development.

Introduction

The New York City Louis Stokes Alliance for Minority Participation (NYC LSAMP) at the City University of New York (CUNY) has, since its inception in November 1992, been at the forefront of a concentrated effort to substantially increase the number of underrepresented minority students who pursue and graduate with Baccalaureate Degrees in Science, Technology, Engineering and Mathematics (STEM)¹. The Undergraduate Research Experience is at the center of the LSAMP Scholar experience at CUNY and non-CUNY sites. Each year over 140 Scholars are engaged in a mentored research experience with a CUNY faculty member¹.

It is well documented the importance and benefits of STEM students having some type of international experience^{2, 3}. Additionally, higher education is moving forward with embracing the concept of educating engineers as a global citizen⁴. Therefore in 2008 an approach was implemented to allow LSAMP scholars to integrate an International Experience into their undergraduate studies. The multi-pronged approach consists of, 1) collaborating with existing programs within the NSF and other federal agencies, 2) working collaboratively with a core of mentors/faculty who have international collaborations, 3) working closely with Departments, Institutes and Centers at CUNY who have international agreements, significant international research focus, and 4) working collaboratively with the Florida, Philadelphia, SUNY and Peach State programs, all of which have some developed program activities in international research.

Our objective was to create an authentic international research model that links culture/language, research, and community engagement using a case study approach in Cartagena, Colombia. We will outline the major components of the model, and benefits to the students, international host and home institution.

Program Background

The city of Cartagena is located on the Caribbean coast of Colombia in the southern tip of South America. Cartagena is designated a Tourist area in the department of Bolivar and faces increasing housing pressures because of internal conflict (in 2008 with displaced populations) and the modernization of the central city for retail and tourism⁵. Small communities in close proximity to the city are seen as areas for development. The program was centered in the communities of Boquilla, which consists of five towns (*veredas*): La Boquilla, Manzanillo, Zapatero, Tierra Baja, and Puerto Rey. These communities have clear distinct histories and characteristics related to population size, major activity (agricultural/marine), transportation, income levels, access to potable water, and sanitation^{6,7}.

Previous research work by the University of San Buenaventura (USB) SYPRES, in collaboration with the Pro Boquilla Foundation, on the five communities that comprise Boquilla produced a Community Needs Assessment (CNA) for the five towns that comprise Boquilla^{8,9}. In conducting the research, over 1500 households were interviewed in the towns of Boquilla, Tierra Baja, Puerto Rey, Manzanillo del Mar and Zapatero^{8,9}. The SYPRES research team identified Health and the Environment as major challenges for the communities¹⁰.

Model

The NYC LSAMP International Summer Research (ISR) program in Cartagena, Colombia, provides LSAMP Undergraduate Scholars students an international research experience. The program was designed to continue the development of general research skills such as, 1) connecting coursework material to laboratory results, 2) literature review, 3) research report writing, and 4) data analysis. The three areas of ISR program focus are, 1) research, 2) culture, and 3) language. The model starts by creating relationships at an international university. From the initial relationships started we started to develop three components of the program. The research projects consisted of environmental monitoring to the current university led social programs in the community. The Cartagena, Colombia ISR program used a cross-cultural approach to accomplish language exchange. This consisted of pairing a Colombian Spanish speaking student to an English speaking CUNY student for the duration of the program. Student research pairs differed in different components of the program, like lab, classroom activities, and cultural excursions. The community projects were created based on existing partnerships between the Non-Government Organization (NGO) and the international university.

Program Elements/Structure

- LSAMP Scholars and students attending USB were selected to form the research team of CUNY and USB students.
- Students attending USB earn four (4) college credits towards their degree for participating in the program.
- All students (USB and CUNY) share a common housing arrangement for the ten week duration of the program to facilitate logistics, cultural exchange, research progress, a buddy system and language immersion.
- A resident graduate supervisor is present with the team for the duration of the summer program.

- CUNY graduate students rotate every two weeks and provide special topic seminars to the team participating in the research.
- Special Lectures in Urban Studies, Professional Development, Environmental Studies, Colombian History-Palenque, and the Pro Boquilla Foundation.
- Community Service activities (once per week for ten weeks) working with the Pro Boquilla Foundation
- Language Immersion (three hours per day first three weeks).
- Academic Coordinator and Program manager available via Skype for group discussions and individual conferencing.
- Public Poster session and Poster session/reception.

Model Implementation: Cartagena, Colombia

The city of Cartagena, Colombia was chosen because of the historic context in the History of Latin America (a UNESCO World Heritage City), previous collaborative relationships with the Pro Boquilla Foundation (an NGO)¹¹ and accessibility to laboratory space at the Universidad de San Buenaventura and the University of Cartagena, on-going research in the communities of interest, numerous environmental challenges facing the communities, and the diverse culture of Cartagena (linked to Colombia's history).

The ISR program was modeled after the standard ten-week NSF Research Experience for Undergraduate (REU) program¹². Students participate in pre-departure assignments, and are provided a daily agenda for the ten-week program. Program operations typically begin the first week of June, and end the second week of August. An on-site coordinator serves as a liaison to the collaborating NGO (Pro Boquilla Foundation), and university partners and supervises the Evenings and Sundays (listed as free time in Table 1. The typically weekly agenda is shown in Table 1.

Colombian students from the universities were selected to participate in the ISR program by their department with guidance from the LSAMP coordinator. Students were selected from only the chemistry, chemical engineering, and math department. This was due to the limitation of the elective credit given by the university. Inclusion of local university students helped students familiarize with the community at a faster rate. It also acted as a component to increase cross-cultural exchange amongst the group.

Table 1. Typical Week for Summer Program

Monday	8am – 12pm: Field Sampling Zapatero	2pm - 3pm: Language Class
		3pm-6pm: Lab-Sample Analysis
Tuesday	8am – 12pm: Field Sampling Tierra Baja and Puerto Rey	2pm - 3pm: Language Class
		3pm-6pm: Lab-Sample Analysis
Wednesday	8am – 12pm: Field Sampling Boquilla and Manzanillo	2pm - 3pm: Language Class
		3pm-4pm: Seminar
		4pm-5pm: Learning Seminar: Literature Review and Citations

Thursday	Lab-Sample Analysis all day	
Friday	8am-12pm: Lab-Sample Analysis	1pm-2pm: Seminar
		3pm-6pm: Lab-Sample Analysis
Saturday	9am – 12pm: ProBoquilla Service: Community Service	
Sunday	Free Time	Free Time

Each day, mornings are assigned to field sample collections, as the heat index is highest at noon. On completing lunch (as a group), the afternoons consist of selected lectures and laboratory work. Students receive a total of three formal hours of Language/Culture (Spanish/English). A biweekly exam is also administered. Each Saturday is dedicated to community service at a local high school in Manzanillo (a fishing community). At the site, students, ages 8-15, get instruction in English, Mathematics, Technology, the research project. A major component of the Social interactions occur via a pick-up soccer game.

Weekly seminars were conducted by Colombian faculty members, visiting doctoral students from CUNY and the University of Florida. ISR participants were exposed to current research projects underway at the collaborating universities in Colombia, and the doctoral research projects (Life, Physical and Engineering disciplines). Students were also engaged in discussions with the visiting doctoral students about the graduate study and career options. A second series of seminars, called Learning Seminars, were also conducted by the on-site coordinator and visiting graduate students. Topics covered included data analysis, nanotechnology, research presentations and literature review, technical report writing, data presentation and poster presentations.

Organized cultural excursions were confined to once per week. These trips provided the students with exposure to various cultural experiences available in Cartagena, Colombia. One such excursion was a visit to San Basilio De Palenque. San Basilio De Palenque was founded by runaway free Africans, and is oldest Afro-Colombian community. The tour consisted of the history of the arrival of Africans in Colombia. Other excursions included eco-tours of the research communities, historic naval forts, and architectural tour of the old city buildings.

The ISR research focused on environmental monitoring in the five *veradas* of Boquilla and could be accomplished utilizing the laboratory equipment in any university level General Chemistry laboratory. Hence students participating required only one year of chemistry and was based on colorimetric determinations utilizing HACH systems and a spectrophotometer. The use of Geographic Information System (GIS) technology combined with Global Positioning (GPS) tools was integrated into the research program. ISR projects and locations are shown in Table 2.

Table 2. ISR Projects, Locations and Sampling

Project Number	Project Location	Project Name	Sample Type
1	La Boquilla	Beach Quality	soil/sediments and water

2	Manzanillo	Beach Quality	soil/sediments and water
3	Zapatero	Effect of Septic Tanks on Soil Quality	water
4	Zapatero	Effect of Septic Tanks on Near By Water Quality	soil/sediments and water
5	Tierra Baja	Effect of Septic Tanks on Soil Quality	water
6	Puerto Rey	Effect of Septic Tanks on Soil Quality	water

Access to the communities was facilitated by the Pro Boquilla Foundation, a Cartagena based NGO working with the local universities. The initial research project objective is to produce environmental monitoring baseline data of water, soil, and aquatic food systems. The investigation of these systems included analysis of parameters such as pH, dissolved oxygen, organic matter, chlorine, turbidity, nitrogen, phosphorus, soil porosity, soil water capacity, fecal coliform, mercury and iron. All reagents and products were purchased from Hach Inc. or Sigma Aldrich. All parameter protocols used were EPA approved methods. Standard reference solutions along with reference blanks and controls were utilized and analysis was run in triplicate.

A GPS unit was given to each student team. The GPS used for this research was a Garmin-eTrex Legend HC series device. The Garmin GPS device was used to map each community and the sampling area. At the field site students took samples of water and sediments at various locations within the neighborhoods. Locations were recorded in areas such as along a river bank, water retention ponds, and several locations surrounding septic tank systems at each house. For each sample location a set of GIS points were taken to ensure accuracy and precision for future testing at the same location.

Student Feedback Survey

At the end of the summer program students were given an anonymous survey and asked to evaluate the program, summarized in table 3. Students thought the program had professional value and that they were satisfied with the program. The highest averages were seen the third time the program was offered.

Table 3. Student Feedback Survey Summary

	2009	2010	2012
Total number of students	11	16	12
Number of students completed survey	10	11	8
Professional value out of 10 (standard deviation)	9.6 (0.70)	8.7 (1.6)	9.8 (0.70)
Overall satisfaction with the program out of 10 (standard deviation)	8.8 (0.84)	8.2 (1.5)	9.6 (0.80)

Open Ended: How do you feel at the end of the program?	“The research projects were very good because we were able to learn about life and value things.”	“Overall the trip was very inspirational.”	“It was an amazing experience! I feel very fortunate and grateful.”
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Discussion and Conclusions

The program model was tested as stated above for two consecutive years in Cartagena, Colombia see Table 4. After which, different parts of the model were optimized for better performance and budget.

Table 4. Model Years in Cartagena, Colombia

Year	CUNY Students	Colombian Students
2009	5	6
2010	9	7
2012	6	6
2015	3	6

The number of participants varied each year to find the optimal group size for this type of program. We felt a size of 12 – 15 students in the group worked best logistically, working in the labs, cost effectiveness and for good group dynamics. In 2010, a group size of 16 was too big to manage the group dynamics, bottle necking in the lab during analyses, cost issues due to a need for a larger vehicle for field sampling, etc.

Our results shows that ISR participants gained numerous research skills and were able to integrate an international experience into their undergraduate portfolio even at the sophomore level with limited research experience and foreign language skills. The model utilized a standard REU model with a scientific theme based on environmental monitoring, augmented with professional development (seminar series), language and culture and civic engagement (community service). This program format can be used as a template to increase the level of STEM students who are able to integrate the international research experience into their curriculum and develop global competencies.

CUNY and Colombian student feedback appreciated the professional development skills that were learned, the professional network that was created, and the once in a lifetime experience. The Colombian students were awarded an opportunity in the following summer to conduct research at CUNY. To date 5 Colombian students conducted summer research internships in the field of chemical engineering at CUNY. We encourage and guide the Colombian students to take the TOEFL and GRE who show interest in applying for graduate school in the US.

The CUNY students that went through the program are doing well academically and in life. The 2009 cohort has 1 current MD/MPH with a BS in Biochemistry, 2 graduated Master degrees (Geoscience and Mechanical Engineering), and 1 graduated BS degree in Mathematics who is currently pursuing a MPH degree. The 2010 cohort has 1 with a PHD in Environmental Engineering, 1 current PHD candidate in Chemical Engineering, 2 graduated Psychology degrees, 1 Masters in Biology on the medical school track, and 1 graduated with an Economics degree wishing to pursue a career at the FBI. The 2012 cohort has 2 students in Engineering industry (Boeing and TATA consultants), 2 community college students transferred to a 4-year institution, and 1 graduated with BS in Biology applying to PHD programs. The 2015 cohort has 2 community college students who transferred to a 4-year institution and 1 Master student in Environmental Science. Unfortunately little information is known on the status of the Colombian student cohorts.

Some challenges in implementing the ISR program model were miscommunication with immigration officials due to visas requirements, ordering supplies in a timely manner, and logistical issues due to erratic traffic patterns. In addition students' group dynamics were at times not easy to manage. However, overall these challenges were conquered through several iterations of the program. For example, in 2010 we learned that a group of 16 was too big to handle logistically (i.e. in the lab and the field). In 2012 the model was then expanded to Cali, Colombia, Quito, Ecuador, and Bahia, Brazil. The model has the potential to fit all STEM disciplines such as technology, clean water, computer programming.

Acknowledgements

We would like to thank the staff in the LSAMP office in making this program run. We thank the faculty and staff at the Universidad de San Buenaventura and Universidad de Cartagena for all their help and support. Additionally we want to thank the student participants for giving 100% effort in the summer program. We thank the manager and staff at Hotel San Felipe in Cartagena, Colombia, which was the students' home while abroad. We thank our on-site coordinators who made the day-to-day operations work. We would like to thank the NSF for funding the CUNY LSAMP program.

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