



## Broadening Participation in Engineering: U.S.-Trinidad-Anguilla Partnership

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Prior to arriving at The Lincoln University, she managed the global curriculum portfolio for over a hundred and twenty programs in sixteen countries at Arcadia University and was instrumental in successfully developing and implementing study abroad opportunities and exchanges for undergraduate engineers from institutions across the country, while internationalizing the engineering curriculum through cooperation, consortia and curriculum integration.

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## **Introduction**

African Americans are underrepresented in both the engineering workforce and study abroad. 61.7% African American students who enter engineering programs do not graduate in this major.<sup>1</sup> This translates to an engineering workforce that comprise; about 4% African Americans.<sup>2</sup> While African American students account for 15% of the overall U.S. undergraduate population, they only represent 5.6% of the over 300,000 U.S. students studying abroad.<sup>3</sup> There are several reasons for this disparity; finances, faculty leadership, high attrition rates, family support, anxiety resulting from travel inexperience, and lack of insight to the correlations between global cultural competence and career goals.<sup>4,5</sup> Research shows that students who have abroad experiences; graduate on time, with higher GPAs and that the travel opportunities foster cognitive analytical and affective organizational learning proficiencies which are *sine qua non* for academic success.<sup>3,6</sup> Bowman and Sage summarized: "*Preparing a diverse, globally-engaged scientific and technological workforce necessitates strengthening international research opportunities for students underrepresented in Science, Technology, Engineering and Mathematics (STEM) fields*".<sup>7</sup> The engineering workforce can only benefit from a significant proportional increase in culturally competent African Americans especially in today's increasingly global economy. Historically Black Colleges and Universities (HBCUs) can play an important role in solving this national challenge.

Of the remaining 107 HBCUs operating in the U.S., only 20% have ABET accredited engineering programs. Lincoln University, is the nation's oldest degree-granting HBCU. Since its inception in 1854, Lincoln has tirelessly endeavored to mold its student body into one that can accept the grand challenges of contemporary society. Thus, in fall 2014 the University started its Engineering Science Program (ESP) and made a deliberate decision to infuse study and research abroad into the curriculum as a retention and competency-building strategy. This paper charts the growth of the ESP and describes the subsequent partnerships among Lincoln University of Pennsylvania, The University of the West Indies in Trinidad and Tobago, and Anguilla Community College in Anguilla as well as the resulting impact on the minority participants.

## **Lincoln University & the Engineering Science Program (ESP)**

The mission of Lincoln University has always been to prepare its students to be leaders of the highest caliber, both at home and abroad. Notable alumni include: African leaders such as Nnamdi Azikiwe, first president of the Federal Republic of Nigeria; Kwame Nkrumah, first president of the then newly independent country of Ghana; and most recently, 1994 graduate Saara Kuugongelwa-Amadhila, Namibia's first female Prime Minister. Here in the U.S. notable alumni include: Thurgood Marshall, the first African American U.S. Supreme Court Justice; Langston Hughes, world-acclaimed poet; Lillian Fishburne, the first African American female U.S. Navy Rear Admiral; and Hildrus A. Poindexter, the first African American to earn both an M.D. (1929, *Harvard University*) and a Ph.D. (1932, *Columbia University*) as well as the first African American internationally-recognized authority on tropical diseases.

Lincoln is always finding opportunities to better prepare STEM majors for careers and graduate studies in STEM-related fields. There are several factors that have historically contributed to the lack of minority STEM degree holders, these include; poor K-12 academic preparation, loss in confidence and lack of support and mentoring. At Lincoln University, many students are plagued

by these factors because of the high population of first-generation, low-income African American students. However, Lincoln's STEM programs have a strong track record of educating minority graduates to produce the next generation of highly trained scientists and scholars. Prior to fall 2014, the University offered 3 + 2 options, whereby students, particularly Physics majors would complete three years at Lincoln and then move on to a partner institution to complete the last two years of an engineering curriculum. Upon completion, students would be awarded two degrees. This model, however, proved to be unsuccessful for various reasons including; students having to stay at the second institution for three or four years, attrition and inability to integrate into the new environment. The decision was therefore made, to transition from the 3 + 2 articulation model to a full 4-year Engineering degree program, whereby students would obtain an Engineering Science degree from Lincoln with the option to specialize in Civil & Environmental or Electrical & Computer concentrations.

While Lincoln's STEM programs have a strong track record of educating the next generation of minority graduates, it was with the understanding that strong support must be made available for the ESP's students to narrow the gap between current national minority and majority engineering students' performance. The vision of Lincoln University's ESP is to educate and produce graduate school- and/or industry-ready engineers who will become leaders in their communities. One strategy to accomplish this goal is to expose students to global contemporary issues, tools and methodologies, by providing structured opportunities to interact with professionals in the field as well as their day-to-day projects. Thus, global partnerships and subsequent access to international research opportunities were actively pursued and provided to students enrolling in the program.

### **Growth & Global Partnerships**

During the first year of the Engineering Science Program, the primary focus was developing, establishing and implementing the curriculum. Enrollment primarily consisted of current students completing Physics degrees with the hopes of continuing to graduate studies in an engineering field. Thus, for the summer 2015 pilot Faculty-led STEM Research Internship Program only one of the five STEM participants majored in Engineering. The experience was primarily sponsored by the Greater Philadelphia Louis Stokes Alliance for Minority Participation (Philadelphia AMP) and was hosted by the Faculty (College) of Engineering at The University of the West Indies (UWI) – St. Augustine Campus in Trinidad and Tobago. The partnership among Lincoln, UWI and Philadelphia AMP evolved out of consortium membership and faculty network. Dr. Monica Gray, the program's creator, is an UWI engineering alumna and Lincoln is a founding member of Philadelphia AMP. UWI – St. Augustine is one of the four campuses of the premier regional university system serving seventeen countries of the Commonwealth Caribbean and home to the flagship Faculty of Engineering. Its mission is to enhance Caribbean development by collaborating with regional and international partner institutions to establish networks for the next generation of leaders. As a regional university, U.S. students are able to interact with students from multiple Caribbean islands simultaneously. The Philadelphia AMP is funded by the National Science Foundation and is considered a senior level Alliance with a mandate to provide international STEM research opportunities for students under-represented in STEM fields. The mission of the Alliance is to substantially increase the numbers of under-represented minorities earning baccalaureate and advanced degrees by employing recruitment and retention strategies at the college level to promote minority talent in STEM disciplines.

A full description of the summer 2015 experience can be found in the literature.<sup>3</sup> In summary, each student worked on an individual comparative research project which was tailored to interest and major but could also be accommodated by our UWI host. The five comparative research projects were water treatment, wastewater treatment, solid waste management, food production and soil management. The international portion of the program was a mirror image of the U.S.-based field studies culminating in PowerPoint presentations in Trinidad. Students continued their research upon return to the U.S., resulting in poster presentations at Lincoln University's fall Annual Science Fair. Notably, three of the five participants placed in the top three of their categories. Participants were also required to attend a series of professional development activities with the Office of Career Services with the aim of helping them update their resumes and articulate the research abroad experience to future employers and graduate schools. All students completed all requirements of the program.

The most challenging aspects to the program revolved around coordinating field trips in both countries. The program featured field studies in the U.S. with "mirror" experiences in Trinidad. For the most part, similar experiences were coordinated but this was not always possible. For example, getting a tour of water or wastewater treatment plant sometimes proved difficult in one or both countries. When equivalent experiences were not possible, substitutes were made and the research plan adjusted accordingly. For example, for the food production comparative research, a snack factory in Pennsylvania was toured while a brewery in Trinidad facilitated students. The research was adjusted to focus on sustainability strategies around waste and water at both companies. There were potential barriers such as: students having never travelled, did not have their passport or proper documentation to get one. The provision of scholarships for the abroad experience helped to offset the cost for obtaining required documentation. In addition, due to travel inexperience, family members needed reassurance of the benefits of the program as well as the students' safety. In anticipation of the growth of the ESP, the initial pilot was used to make plans for the following summer. These included, more participation from UWI's engineering professors and subsequent access to their ongoing engineering design projects. Primary feedback from participants were requests for extending the Trinidad leg of the program by about a week and more interactions with Caribbean students. Due to funding challenges, the time could not be extended, however, the Lincoln contingent arrived earlier in the summer before UWI students left campus to facilitate more student interactions.

The 2015 – 2016 academic year saw an increase in enrolment in the ESP. Thus, six of the eight participants in the summer 2016 instalment of the Faculty-led STEM Research Internship Program were engineering majors. One of the remaining two students was a Physics major who was taking engineering courses and would eventually go on to pursue engineering in the graduate program at Drexel University. The program was again hosted by UWI-St. Augustine and funded in part by Philadelphia AMP. Students were paired to form four research groups. Summer 2016 focused on an expanded partnership with University of the West Indies whereby four professors from the Faculty of Engineering partnered with students on engineering design projects including "*Optimization of Banana Fiber Extraction Device*", "*Investigating Fatigue Strength of Engineering Materials: Natural Frequency Approach*", "*Determination of Soil Aggregate*

*Stability by Wet Sieving” and the “Application of Total Quality Management Tools to Determine Treatment Plant Efficiency”.*

Now in its second year, the logistics were easier to coordinate between the two countries as many of the experiences were repeats from the previous year. The main challenges resulted from high turnover in key positions at Lincoln University and the relative “newness” of the program and funding mechanisms being employed. That is, the International Research Internship Program is currently Lincoln University’s only faculty-led STEM opportunity. While the graduate business program had an annual faculty-led program, the experience is rolled into the student’s tuition. This difference had major implications especially in the context of a collective bargaining agreement and traditional accounting processes. There is a need for restructuring as this and similar programs are developing in the future. In addition, as the relationship between the UWI and Lincoln developed, a MOU was developed to concretize the partnership. However, changes in upper administrations at both institutions have delayed that process significantly. Further, attrition is even more pronounced given the relatively small sample sizes. Of the eight students in the summer 2016 cohort, two withdrew from the institution, primarily due to financial challenges.

### **Broader Impacts**

While Lincoln University has always had a global vision, STEM students were not directly targeted towards fulfilling the global competency mission. Considering Lincoln’s long history serving minority STEM majors, the imperative to prepare students for the global marketplace, the mandate arising out of membership in the Philadelphia AMP to provide “*international research opportunities for students under-represented in STEM fields*” and the desire to offer this life changing experience to more students, it has been concluded that the STEM fields were areas of synergistic and strategic growth. Consequently, Dr. Richard Green, the then Interim President invited Dr. Robert Johnson of St. Clouds State University, an expert on STEM-related campus internationalization, to campus to speak to relevant cohorts across all departments. As an outcome to those meetings, the Committee on International-Global Initiatives (CIGI) was formed to address the issues of increasing the availability of study abroad opportunities, increasing international student enrollment, creating opportunities for international faculty development and expanding of an internationalized curriculum. One of the first tasks of the CIGI was to develop a process for assessing and approving faculty-led programs. During the first call for faculty-led programs for summer 2017, the committee received nine (9) applications, which showed tremendous interest and growth campus-wide. In addition, the committee moved from *ad hoc* status when it was voted in by the Faculty as a bona fide Faculty Standing Committee. It is expected that the committee will provide the necessary structure to streamline faculty-led programming.

The success of the Faculty-led STEM Research Internship Program to the Caribbean facilitated an application for the very competitive U.S. Department of State’s U.S.A Study Abroad Capacity Building Grant in 2015. The successful proposal featured an expansion in Caribbean partnerships to include Anguilla Community College (ACC). As the only community college in Anguilla, ACC serves as a feeder school to 4-year partner institutions like Lincoln University. The relationship between ACC and Lincoln University is again, a testimony to faculty network, in that the President and CEO of ACC was formerly a well-esteemed faculty and administrator at

Lincoln. The grant made it possible for Dr. Monica Gray to travel to Anguilla in December 2016 on a site visit. Dr. Delroy Loudon, the then President and CEO of ACC facilitated a meeting with ACC's Board of Directors and General Council on a MOU between Lincoln and ACC. There were discussions on logistics such as room, board and transportation for Lincoln University's students doing research in Anguilla. Dr. Gray also met with the Minister of Education and Permanent Secretary of Education for discussions on governmental support for bidirectional student mobility between Anguilla and Pennsylvania. Lincoln University's allocation of five (5) scholarships is timely and is synergistically consistent with the Ministry's appropriation of funding for Anguillans to study abroad. Dr. Gray toured the Anguillan Desalination and Brackish Water treatment plants, a centralized wastewater treatment plant and public health laboratory to ascertain laboratory and field studies opportunities in the areas of water resource management and public health. Lincoln University's STEM students will have an opportunity to engage in high impact research opportunities in the future. Five full scholarships (tuition and fees) were earmarked to ACC graduates electing to study STEM, particularly engineering, at Lincoln.

As Lincoln University's Engineering Program continues to grow, the expectation is that multiple faculty-led experiences to these various locations will occur over short breaks and during the summer as well as students can embark on individual semester opportunities. For example, during the development of the ESP curriculum, spring semester of the sophomore year, was made to mirror spring semester of the first year at UWI-St. Augustine to facilitate future semester-length student exchanges. An aspirational goal of this program is that each engineering student will have at least one study and/or research abroad experience before graduation. Further there is need for adaptation of an assessment instrument to evaluate the global skills the students develop because of these international research experiences. Several instruments are being considered, such as, Beliefs, Events, and Values Inventory (BEVI), Global Perspective Inventory (GPI) and Intercultural Development Inventory (IDI).<sup>8</sup>

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