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HSI conference proceedings: Accelerating the impact of HSI STEM education and research on innovation ecosystems

Item Type	Project Report
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Publisher	University of Puerto Rico Mayaguez Campus
Rights	Attribution-NonCommercial-NoDerivs 3.0 United States
Download date	2025-01-17 13:54:10
Item License	http://creativecommons.org/licenses/by-nc-nd/3.0/us/
Link to Item	https://hdl.handle.net/20.500.11801/2528

HSI

Research Internship Programs
**INNOVATION
ECOSYSTEMS**
Collaboration Mentoring

CONFERENCE

HSI Conference: Accelerating the Impact of HSI STEM Education and Research on Innovation Ecosystems, November 8 & 9, 2018, Mayagüez, PR.

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These Conference Proceedings are based upon work supported by the National Science Foundation under Grant No. (NSF # 1802252). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Conference Highlights

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Department of Chemistry
Principal Investigator

Conference Goals

The first goal is to contribute to the design of the Hispanic Serving Institutions program at NSF by: providing recommendations & winning proposals on: experiential learning & undergraduate research, workforce development, and how these strategies provide opportunities in innovation ecosystems.

The second goal is to use these activities to improve STEM education in Puerto Rico and develop our University as a true hub of transformation. This goal requires that we continue communication with the smaller regional HSIs and develop new collaborations. The team has collaborated within the UPRM e-ship network: a community of students, professors, emerging entrepreneurs and companies from different parts of the island who share a commitment to developing a network between innovative minds and creating new opportunities. This innovation community should be expanded to other universities.

Major Activities:

The activities were organized to achieve the principal objective - the HSI Conference under the theme: Accelerating the Impact of HSI STEM Education and Research on Innovation Ecosystems.

The event was held at the Mayaguez Resort on November 8th & 9th, 2018 and brought together 185 students and faculty participants from 37 HSI institutions.

The pre-conference NSF grant writing workshop included 49 participants and was held at the Mayagüez campus of the Pontifical Catholic University of Puerto Rico. This was the only HSI conference held in Puerto Rico, and provided input to NSF on how to expand active learning opportunities for undergraduate populations at HSIs by linking these students with mentors from both the commercial and knowledge economies.

The conference started with a poster session that allowed all attendees to meet with students participating in research and various active learning projects at the University. The poster session served to emphasize that the activity was organized for improve STEM opportunities for students. The objective was that each conference speaker and participant would have an image of our talented students. The demographic list (supplementary document) shows the wide student participation of the two days. Over 30 different projects were presented (the list is included as

supplementary materials). This poster session also provided networking opportunities among all conference attendees.

A web site: http://uprm.edu/hsi_innovation/, which was essential for the promotion of the HSI conference, was also developed.

The project involved a series of pre-conference activities:

1. 5th National Forum on Entrepreneurial Education in Puerto Rico, June 7 & 8, 2018 “Accelerating the Impact of the Innovation Ecosystem.” This Forum brought together 81 participants from twelve local HSIs, five teachers from the Puerto Rico public schools, three entrepreneurs, and four different organizations.
2. NSF Proposal Writing Workshop, November 7, 2018 at Pontifical Catholic University of Puerto Rico, Mayaguez Campus. The NSF speakers included: Andrea Johnson, Minerva Cordova, and Mr. L. Rashawn Farrior.
3. The PI and two co-PI’s (Lugo and Cordova-Figueroa) also participated in the “Strategic Doing Community Workshop to Strengthen Puerto Rico,” held in April of 2018 in Santurce, Puerto Rico. Dr. Ubaldo Córdoba and Dr. José Lugo completed a 3-day Strategic Doing Train the Trainer workshop (<https://strategicdoing.net/>), provided by Purdue University’s Agile Strategy Lab. Strategic Doing is important to help coordinate efforts in projects with volunteers, where formal direct reporting relationships are not established. The Strategic Doing workshop included the participation of several of Puerto Rico’s private universities and it has also helped us to promote the NSF HSI conference. We believe that Strategic Doing is essential for building partnerships within and beyond our University.

The Resuélvelo Boricua competition was accomplished and the award ceremony occurred during the second day of the conference. The project is described in:

1. <https://www.youtube.com/watch?v=00ofpY8clUE>
2. <https://youtu.be/p7gNZk2eLro>

The video produced by the winning team is found at: <https://youtu.be/YrTsI3rHc0w>

Resuélvelo Boricua developed from the PI's participation in a team that addressed the question: Imagine if all Puerto Rican children had access to an education that would help them solve in a creative manner the problems faced by the island. What project would you design? This project continued to develop and became the Resuélvelo Boricua competition for public middle school children, where a total of 27 schools participated in the first year of the project. The project involved professors from the Universidad Central del Caribe,

Universidad del Turabo, and Universidad del Sagrado Corazón. This competition required an investment of close to \$100,000 from the Puerto Rico Science Technology & Research Trust. The team lead was Professor Sandra Pedraza, Director of Innovation and Entrepreneurship Office, at Universidad Ana G. Méndez, who followed the Strategic Doing approach to achieve the needed collaboration. The team also included Mildred Rivera Marrero, Dean of Institutional Development and Strategic Planning at Universidad Central del Caribe, and Eng. Geydie Figueroa. The Trust dedicated many hours to this project: Andreica Maldonado, Grants Program Manager, Lupe Vázquez, Chief Communications & Marketing Officer, and CEO Lucy Crespo, made many important contributions.

The awards to the schools were presented on November 9 at the HSI Conference held in Mayaguez.

4. The PI provided a presentation to the Arts & Sciences faculty of Inter American University of Puerto Rico at San Germán Campus on April 11, and to faculty from the Pontifical Catholic University of Puerto Rico on August 7, 2018. These conferences provided valuable feedback. For example, the Pontifical Catholic University professors indicated the importance of reaching out to high school counselors. Several professors indicated that many students are focusing on short-term careers. Many high schoolers are indicating interest in becoming automotive mechanics (primarily males) & nursing (primarily females). Why is this occurring? Could it be lack of faith in the system and the economy?

Professors at both universities provided feedback that the ideas behind our HSI conference were interesting, and could provide good opportunities to students. The main concern was their high teaching loads, and the need for institutional change so that they could have the time available to seek for more opportunities for their students.

Specific Objectives:

The specific objectives were:

1. Promotion of the HSI Conference and the NSF Grant Writing Workshop held in Mayaguez on Nov. 7 - 9 to achieve its success. Collaboration with Dr. Carmen Bellido, and Prof. Jaquelina Alvarez, coordinators of the UPRM Center for Professional Enrichment (CEP), Dr. Sylvia Rodriguez, coordinator of the UPRM Research Academy, and Kara Fore, supervisor of the Proposal Development Unit of the Research & Development Center, was pivotal for the planning and marketing of the conference. Promotion involved the development of the web site: http://uprm.edu/hsi_innovation/, letters to the leaders of HSIs in Puerto Rico, visits to a number of neighboring HSIs, and communications with various organizations who have extensive mailing lists (PR-LSAMP, Puerto Rico Science Technology & Research Trust, American Chemical Society). The PI and co-PI also used the LinkedIn and twitter networks for promotion of the activities.
2. Organization of the conference in a way that provided information on the current STEM programs, while fostering discussion on the many opportunities for improvement and

progress. The original proposal contained a draft program, but during the promotion of the conference, many additional STEM related programs on the island were revealed. These programs were incorporated into the conference, as they could provide valuable feedback to NSF. The conference schedule went through several iterations to enable many different programs to present their progress and suggestions.

3. Development of working relationships and alliances that will help us to improve STEM education at UPRM. We will expand the mailing list and contacts developed during the first.

Significant Results:

The principal outcome was a snapshot of STEM education in Puerto Rico:

1. There are many programs and opportunities to improve STEM education on our island, including at HSIs. However, HSIs in Puerto Rico are not taking full advantage of available funding opportunities, which is an identified need area.

The pre-conference presentations provided by the Pontifical Catholic University of Puerto Rico and Inter American University of Puerto Rico at San Germán Campus revealed that many of the research opportunities for their students were through collaborations such as PR-LSAMP (Puerto Rico Louis Stokes Alliance for Minority Participation), the Ronald E. McNair program. The NIH-funded Puerto Rico Idea Networking of Biomedical Research Excellence (INBRE) is also an important collaborator for these universities. The professors at these universities were well aware of the importance of collaboration with larger HSIs, to obtain access to research projects and instrumentation that are not available at their campus.

Pre-conference activities also revealed the importance of the Amgen BioTalents program (<http://www.uprm.edu/biotalents/>) housed at UPR-Mayaguez, but open to students from all of Puerto Rico's institutions. This program includes workshops and conferences on biotechnology that are offered throughout the island. This program is well-known by the majority of smaller HSIs which encourage their students to participate.

UPR-Mayaguez is currently collaborating in innovation and entrepreneurship efforts with Universidad del Turabo and Universidad del Sagrado Corazón. However, many other collaborations are possible.

2. Internships and active learning opportunities can be transformative for students as described by Dr. Angela Gonzalez-Mederos in the Conference Proceedings. However, these opportunities go beyond simply posting or announcing these opportunities to students, due to unique social and cultural pressures faced by students in Puerto Rico. Students and their families are often unprepared for internship opportunities, both financially and emotionally. Dr. Gonzalez has had students turning down summer internships because they needed to care for a family member. Dr. Gonzalez indicated: "We recognize that family has been a key element in the success of our program participants. Including activities where parents are invited gives them and the students' security and confidence about the program, and the family is more engaged with student success."

Dr. Gonzalez also observed the strong impact on student development that these internships and extracurricular activities have.

3. The innovation and entrepreneurship activities at UPR-Mayaguez, Universidad del Turabo, and Universidad del Sagrado Corazon are very innovative in terms of STEM education. There are many opportunities for learning from the School of Business and bringing these ideas to STEM. These opportunities were clearly outlined at the 5th National Forum of Entrepreneurial Education in Puerto Rico was held as a pre-conference activity June 7th-8th, 2018 on our campus. The keynote lecture was focused on mentorship. The concept of mentorship has been recognized as crucial for the development of startups. Mentorship has been carefully studied in entrepreneurship and could provide many valuable ideas for STEM education. Different stages of business development require different mentors. The mentor for a startup is not necessarily the same as the mentor to help a company export their products. In the same way, the mentorship that a STEM student needs differs when transitioning from a 2-year to 4-year institution, as when deciding to attend graduate school. The mentorship that a first year chemistry student needs is not the same as that of the student that is near completing the B.S. degree. The concept of mentorship has evolved recently in the innovation and entrepreneurship domain, and there are many possibilities for the extension of these ideas to STEM education.

Our educational approaches should emphasize that students should not be afraid of new opportunities. Dr. Angela Gonzalez-Mederos from Inter American University in San Germán campus also noted in the Conference Proceedings that: “One of the benefits of experiential learning opportunities is that students learn to be independent and they are not afraid of new opportunities. Many students are looking forward to graduate and create their own business. Creating interdisciplinary activities, that combine science and entrepreneurship will prepare them for their future endeavor. From our first round of programs one student set up her own farm and another started a cafeteria using locally grown products, of which she learned during our programs.”

Inter American University of Puerto Rico at San Germán Campus has also developed a course focusing on the development of business ideas related to science, using the scientific method to develop those ideas. The Conference Proceeding by Dr. Luz Leyda Vega-Rosado and Dr. Angela Gonzalez-Mederos indicates: “Resources are needed to provide release time for faculty from business and science to be guides or mentors of the students in projects related to STEM areas such as: agriculture, animal science, pathogens and to do market research in those and other entrepreneurial areas.”

Dr. Jose I. Lugo, co-PI in this grant, is now starting to carry out the different activities related to the first NSF I-Corps Sites program and UPR-Mayaguez.

4. There are capstone projects at our University, such as the Chemical Engineering Capstone course presented by Dr. Lorenzo Saliceti, that are already involving industrial mentors, and providing excellent active learning opportunities for students. Capstone courses provide a unique opportunity for developing industrial support of HSIs. Capstone course also help students see how the science that they have learned is applied.

5. There is still a lot of potential for building STEM capacity at local HSIs. A number of participants at the NSF Grant Writing workshop were exposed to the definition and importance of intellectual merits and broader impacts for NSF grants. Some of the institutions were not aware of when they last submitted a grant proposal to NSF. The participation of Levar Rashwan Farior was important in providing the financial and legal angle in University - NSF relations. His presentation covered the basic requirements for a fiscally sound relationship between an institution and NSF, which was essential information to HSIs with little or no prior experience working with the agency. An experienced UPRM grant support specialist spent close to an hour speaking with Mr. Farior and obtaining answers to many questions. More interaction with personnel from the Division of Grants & Agreements would be beneficial to all institutions.

Key outcomes or Other achievements:

Historically, there has been an attitude of competition between Higher Education Institutions in Puerto Rico, even amongst branch campuses of the UPR system. A key outcome of this conference was to help change that perception to see smaller HSIs as an important network of collaborators, for both faculty and students. The progress of all institutions in PR is essential to expanding STEM educational opportunities to students. Students from the smaller HSIs could eventually become graduate students in our programs. We are all part of a research ecosystem that is essential for economic development. We now have more communication with the smaller HSIs and are looking forward to future collaborations.

While many programs and opportunities are available to our students, there is room for growth. Faculty members need to spend more time exploring grant opportunities. We need to encourage our students to do the same. Grant programs could also bring new personnel to work on these programs as noted by Dr. Lourdes Echegoyen in her presentation.

What opportunities for training and professional development has the project provided?

The project has provided development opportunities for undergraduate and graduate students that performed many of the administrative and communication activities.

Undergraduate students Sara Liah Acosta and Alondra Toledo developed the registration forms for the HSI conference, collected data, and welcomed participants to the conference. Sara is a highly talented undergraduate student, a participant of the Summer Venture Management program by Harvard Business School in June 2018.

Alondra Toledo, made important contributions to our project during her final semester and has now completed her degree in marketing. Alondra applied her project management skills to develop a “to do” list which was very valuable throughout the entire project. Alondra is the founder of the Startup UNDERSHAND. She has participated in the Enterprise competition sponsored by Grupo Guayacan. She won the Global Student Entrepreneur Award, from the Entrepreneurial Organization-PR chapter, because she demonstrated the best entrepreneurial techniques through the competition.

Ph.D. candidate Leishla Cruz from the Chemistry Department performed many of the administrative activities, and was also in charge of many of the details of the poster session. Leishla

learned to perform many administrative functions from a former administrative assistant from the Chemistry Department. This knowledge has helped her obtain additional funding for her graduate studies.

Our students showed that they can play an important role in the coordination of projects such as this one.



Our conference team: left to Right: Leishla Cruz, Ph.D. Candidate Applied Chemistry, Dr. Sylvia Rodríguez Abudo, Alondra Toledo, Sara Liah Acosto, Jaquelina Alvarez, Dr. Jose E. Lugo, Dr. Canny Bellido, Dr. Rodolfo J Romañach, and Kara Fore.

How have the results been disseminated to communities of interest?

The Resuélvelo Boricua project emphasized the importance of active learning by involving Puerto Rico's public middle schools. The 27 competing schools developed a three minute video where they proposed solutions to: : 1. How to improve the math skills of intermediate grade students with active learning techniques, 2. How to improve the environment through recycling, and 3. How to reduce the number of early pregnancies among adolescents. Each team consisted of at least four students. The production of these videos also involved their parents, several of whom attended the HSI conference accompanying their children. We are very proud that two of the three winning teachers were graduates of Dr. Canny Bellido's problem based learning trainings. Two of the awarded teachers were from social science and taught history; certainly an example of the wide applicability of active learning strategies.

The Resuélvelo Boricua competition was publicized in several newspaper articles, and the promotional videos are in you-tube. Several of the videos developed for the competition are also available through you tube providing wider promotion of active learning strategies.

What other collaborators or contacts have been involved?.

1. Inter American University of Puerto Rico at San Germán Campus, the Pontifical Catholic University of Puerto Rico (PCUPR) in both San Mayaguez and Ponce campuses. The PCUPR in Mayaguez provided excellent and comfortable facilities for the NSF grant writing workshop.
2. The Puerto Rico Science Technology and Research Trust (PRSTRT) whose mission is to “invest, facilitate and build capacity to continually advance Puerto Rico’s economy and its citizens’ well-being through innovation-driven enterprises, science and technology and its industrial base”.
3. The Professional Enrichment Center (CEP) formed an alliance with the Research and Development Center (R&DC) to create the Research Academy for Faculty & Postdoctoral Fellows in 2012. The Center covers all aspects of professional development including teaching, learning, assessment, evaluation, technology, and research strategies. The CEP was essential in helping the team in communicating with researchers on campus, organizing the Ignite session, and facilitating discussions during the meeting.
4. The Graduate Research and Innovation Center (GRIC) located in the General Library, is a creative and flexible space to foster collaboration and innovation, where graduate students and faculty can meet to develop projects and receive specialized assistance. The GRIC contributed to the general organization of the event, and in gathering the feedback received.
5. The Proposal Development Unit (PDU) of the Research & Development Center was created in 2009 under an NIH grant to build research capacity on campus. The PDU helped organize the pre-conference NSF grant-writing workshop on November 7th, 2018, offered by NSF EHR program officers. The PDU also consulted and helped revise the original proposal to NSF, communications sent out during advertising of the event, and the project report.

What is the impact on the development of the principal discipline

The project has strengthened collaborations between HSI institutions in Puerto Rico and also helped us to get to know other US HSIs, such as: University of Texas-El Paso, and the City College of New York. We now know that some of the challenges that we face on our campus are not uncommon among HSIs; that funding is available to develop programs to help students through critical transitions; and that NSF is actively working to build capacity at HSIs.

The Resúvelo Boricua project was born from our collaboration with the Puerto Rico Science Technology and Research Trust, the Universidad Central del Caribe, and Universidad Ana G. Mendez impacting middle school children from 27 schools in the first year of the project. These children provided suggestions to the following questions through a 3 minute video: 1. How to improve the math skills of intermediate grade students with active learning techniques, 2. How to improve the environment through recycling, and 3. How to reduce the number of early pregnancies

among adolescents. Each team consisted of at least four students, and the awards included: facilities for active learning, tablets for students, and 3-D printers. Resuélvelo Boricua is also an example of local success in STEM teaching outcomes at UPRM, as two of the three award winning teachers were graduates of the Problem Based Learning professional development projects for school teachers directed by Dr. Carmen Bellido (CEP). During the spring of 2018, Dr. Keith Wayland, Dr. Carmen Bellido, and other UPRM professors led a Puerto Rico Department of Education plan in which 93 Social Studies teachers developed and implemented Project Based Learning (PBL) in their classrooms integrating environmental science research related to post-María community concerns. Responding to a call by Puerto Rico's Secretary of Education for all teachers to implement PBL, in a single semester the plan produced a dozen world class examples of effective PBL. Two of the three Resuélvelo Boricua award winning teachers used the PBL skills learned with Drs. Wayland and Bellido to develop their students' responses to the questions posed. In summary, PBL has been shown to motivate effective in-context STEM learning while integrating STEM learning with other disciplines. Proper PBL implementation as an action learning methodology has a significant impact beyond the immediate training.

Impact on other disciplines?

This project has strengthened collaborations between HSIs. New collaborations are developing, even though their impact will not be immediate. The team that developed this proposal grew from the E-ship Network (<https://www.uprm.edu/eshipnetwork/>), which has evolved since 2015 as a unique community made up of students and professors as well as emerging entrepreneurs from different parts of Puerto Rico who share a commitment to create opportunities for collaboration and networking between innovative minds. However, a similar effort is needed across the UPR system and the island. Dr. Ubaldo Córdova-Figueroa, a co-PI in this project, is now moving this effort to the UPR system, as one of his initiatives as Vice President.

UPRM is currently recognized as a leader in entrepreneurial education. For instance, faculty of the NVDE received a VentureWell award for innovative curriculum development and student engagement in 2017. The presentations from the New Venture Design experience have also generated interest for similar programs at other HSIs.

The HSI conference also included the participation of Juan Bauza from the Economic Development Agency. The development of our University as a true hub of transformation will require the involvement of new entities and the development of new working relationships. The US Economic Development Agency has awarded the UPRM Business Center a grant to develop an Island wide capacity building program to engage municipalities and non-profits in the recovery efforts from Hurricane Maria. A total of 10 undergraduate and graduate students are participating in this project. Thus, new alliances and opportunities are already evolving.

The conference is expected to impact multiple disciplines as it involved broad participation. The conference included representatives of all UPRM engineering programs, and from science programs throughout the entire island. The focus was on active learning opportunities which apply to all fields.

The Puerto Rico Science Technology and Research Trust worked with us in the Resuélvelo Boricua activities, and also participated in the HSI Conference. The HSI Conference was

influential in their hiring of a new staff member, Jorge Valentine, as STEM Program Manager. The Puerto Rico Science Technology and Research Trust is now better positioned to team with local HSIs to seek new STEM educational opportunities.

The progress of all HSIs in STEM education is important. The Innovation ecosystem will grow stronger as all HSIs make progress, and graduate programs will also become stronger thanks to the wider pooled of well-trained students.

It is expected that interaction with NSF representatives and exposure to information related to NSF and HSI programs will help guide faculty in submitting more focused and competitive proposals to the HSI program.



Experiential learning opportunities at Inter American University of Puerto Rico San Germán Campus: changing our scientific culture

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Experiential learning activities have been praised to improve student learning and self-confidence. For the last eight years, students at San Germán Campus of the Inter American University of Puerto Rico (IAUPR-SG) have been participating of experiential learning activities that prepared them for graduate school and future jobs. Experiential learning activities such as professional workshops, shadowing/volunteer, research, scientific meeting participation and internships have been supported thanks to USDA-NIFA-HSI projects. The projects have been a collaboration between University of Puerto Rico-Mayaguez Campus, Florida International University and IAUPR-SG.

In many of those activities, such as shadowing, internships and research, participants were paired with professionals of different areas related to agriculture, natural resources and STEM. Those professionals mentored our participants improving their scientific skills along with their communication skills, both in English and Spanish. All students participating in the first two projects that ended in 2015, are either in graduate school or working in STEM related jobs.

Experiential learning activities are one way to engage students and improve their STEM preparation, providing hands on skills that prepare them better for the future. Experiential learning activities also improve student confidence about their knowledge and their communication skills. Therefore, promoting programs that create experiential learning activities in Hispanic Serving Institutions will enhance quality of undergraduate STEM education, along with retention and graduation rates. Hence, we recommend that NSF-HSI program includes:

1. Student support to participate of experiential learning activities
2. Create experiential learning activities for STEM undergraduate and graduate students
3. Research incentive to HSI that are not research focused institutions
4. Faculty support to provide with time to carry on research and incorporate experiential learning activities within their courses or curriculum. Furthermore, faculty training in STEM research, education and mentoring to Hispanic students.
5. Promote collaborations among NSF funded institutions, researchers and federal offices and HSI to help increase opportunities for students and faculty.
6. Involve the Hispanic families. Hispanics are very close to their family, and many big decisions may depend on them. Family involvement will help to increase engagement into STEM careers. If the close family agrees with career decisions, student will feel more confident and engage better into their own professional preparation.
7. Promote entrepreneurship by creating interdisciplinary teams. Train science and entrepreneurship faculties to better help Hispanics into creating their own successful business.
8. Involve STEM future teachers into the program. Even when the NSF program may be directed towards STEM students, future STEM students will be trained by our present future-teachers. Their involvement will multiply the effect that this kind of project will have in the future.

Experiential learning opportunities at Inter American University of Puerto Rico San Germán Campus: changing our scientific culture

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Inter American University of Puerto Rico (IAUPR) is one of the largest non-profit institution of higher education in Puerto Rico (PR), founded in 1912 in the municipality of San German; its original Campus (IAUPR-SG). It has been accredited by the Middle States Council on Higher Education (MSCHE) since 1944 and it is licensed by the Council of Education of Puerto Rico (CEPR). It has enrolled about 43,000 students, which correspond to about 21% of all Island's college students. IAUPR has eleven campuses around the island and two professional schools (Optometry and Law). (Inter American University of Puerto Rico, January 2017)

San Germán Campus of Inter American University of Puerto Rico is in the south-western region of Puerto Rico. It serves about 4000 students, over 99% are Hispanics and about 54% female. IAUPRSG offers a wide range of academic programs from pre-K to doctoral level programs. The 2017-2018 academic offering includes: twenty-four (24) technical certificates, ten (10) associate degrees, forty-five (45) Bachelors programs and twenty-five (25) master's degrees including one in Environmental Sciences and Science Education. IAUPR-SG also offers four Doctoral programs, including one in Education.

UIAPR-SG has about 800 students in STEM bachelor's programs such as Biology, Chemistry, Microbiology, Computer Science, Electronics, Mathematics and Environmental Technology, and about 45 students in a master's degree in Environmental Sciences. It promotes student participation through Student Council along with more than thirty student organizations, of which 11 are STEM related. Campus Honors and Ronald McNair Programs provide professional opportunities to undergraduate students such as research opportunities and professional and scientific meeting participation for SG students.

San Germán campus is in a mostly rural area with families working in services or agricultural activities, which results in a population with low federal income and within poverty levels. Therefore, most of our students depend on financial aid to continue their studies. Financial Aid funds originate from different sources: the United States Government (Federal Funds – Federal Pell Grant), Government of the Commonwealth of Puerto Rico, Inter American University and private entities. (Inter American University of Puerto Rico, January 2017)

To increase opportunities for our students, in 2011 we started collaborations with University of Puerto Rico – Mayagüez Campus (UPR-M) and Florida International University (FIU), both sponsored by USDA – National Institute of Food and Agriculture (NIFA). Both collaborations aimed to prepare our students to be excellent candidates to pursue a career in USDA areas, providing experiential learning opportunities.

UPR-M collaboration *Center for Education and Training in Agricultural and Related Sciences (CETARS – USDA – NIFA – HSI 2011-38422-30835)* graduated 11 students with science bachelors and three master's degrees in environmental sciences. Our collaboration with *FIU, Florida-Caribbean Consortium for Agriculture Education and Hispanic Workforce Development (FCCaGE – USDA-NIFA-HSI 2011-38422-30804)*, graduated 13 bachelors and 3 master's in environmental sciences. During the five years of the programs, all the participants did volunteer, shadowing or research and participated of summer internships. All the students participated of at least one scientific meeting either in PR or in USA and most of them presented their research work or experiences in a professional meeting. And, besides the extra work, all student maintained or improved their GPA by graduation. After they graduated, 75% of the students went to graduate school and all of them are working in science related jobs.

In 2016, those collaborations were renewed with UPR-M new program: *Encouraging Careers in Food Security and Safety (ECaFSS): A multi-institutional collaborative approach for success in Puerto Rico (ECaFSS – USDA-NIFA- HSI 2016-38422-25541)* program, supporting 12 students and with FIU new program: *Innovative Curriculum for Agriculture Training and Career for Hispanics (iCATCH-USDA-NIFA-HSI 2016-38422-25549)*, supporting 8 students.

All those programs provide experiential learning activities for our participants, such as professional workshops, conferences, meetings and summer internships. Experiential learning opportunities, within our programs, provide students with learning through hands-on activities that reinforce previous knowledge and boost their confidence about their scientific knowledge and communication skills (Lewis & Williams, 1994). Among experiential learning activities in higher education are apprenticeship experiences, field work and practicum experiences, along with volunteer experiences (Faculty Development and Instructional Design Center). Our USDA-NIFA programs have used those experiences to improve student perception of their own capabilities, providing students with professional knowledge and better communication skills. They also provide them a much-needed self

confidence that helps them realize that they have the potential for success either in graduate school, government or industry. (Faculty Development and Instructional Design Center)

Besides, student's improvement, our USDA-NIFA programs also have increased collaborations with other institutions. So, students from UIAPR-SG have done research at UPR-M and FIU. They also have worked at USDA - Veterinary Services, APHIS and Forest Services. Other students have volunteered with Natural Resources, Fish and Wildlife and Sea Grant. Some of them help at private farms, veterinary offices and animal shelters. Those collaborations will remain even after our students graduate, providing opportunities for more students.

However, the biggest change that these programs have made at UIAPR-SG is a change in culture. Before, students at UIAPR-SG did not see the importance of participating in extracurricular activities, such as student association groups, internships or even research. They were happy with their part time job and their good grades. However, that is changing, and more and more students are looking for and participating in different activities. That is how, an increase in students taking research and practicum courses has been seen.

At UIAPR-SG to carry on research, students must participate of programs as those from USDA-NIFA or Ronald McNair Program. If they are not in those programs, they may take Research Methods course. This is a three credit elective course, and students are paired with a faculty member who is willing to guide them in their research project. Since the start of USDA-NIFA programs, more students are taking Research Methods course. The average of students taking the course between 1999 and 2010 was nine students, and it grew to 19 from 2011 and 2018. The number has not increased more probably because the number of faculty accepting students to do research restricts the number of students in that course. Faculty usually do research in their free time because academic load may be from 15 to 21 credits per semester. However, because of the higher demand of students interested in doing research, more faculty is getting involved in research, from two faculty members in 2010, to two faculty and five adjunct faculty in fall 2018.

Another course that promotes experiential learning opportunities within our STEM curricula, is Practicum (BIOL 4965). In this class students do shadow or volunteer work with professionals of the areas they want to explore such as veterinary offices, Natural Resources, Fish and Wildlife sites, physician offices, nutritionists, private laboratories, pharmaceutical industries, and agricultural stations, among others. Student in USDA-NIFA projects do those activities since they start in the program, so they may have four years of experience when they graduate. Students that are not in any program, take this one semester course, with 120 hours of practicum. Even, when it is an elective course, students are increasingly more interested in this course. The average of students taking the course before 2010 was about 6 students, and it doubled from 2011, even when number is limited by the places offering them the opportunity.

Additionally, more students are looking to participate of summer internship. For summer 2018, we got 10 students into internships in USA and one in Spain. Getting into summer internship is not easy for our students, considering that they compete with students that have research experience from their first year or come from renown institutions in the US or PR.

The increase in those courses is a clear indication that culture among our students is changing. Faculty is also being more engaged and therefore helping, promoting and encouraging this change.

However, many of our students do not take these opportunities, because they have to work to support their expenses or family, reducing their available time to do any experiential learning activity. Therefore, our programs (USDA-NIFA and Ronald McNair) provide a stipend that allowed our students to free time from their work, so they could participate of the extracurricular activities we organized, warranting the success of the programs.

Therefore, from those experiences we feel confident to recommend that a program that aims to improve quality of our STEM students at Hispanic Serving Institutions should provide experiential learning opportunities for undergraduate and graduate students, by providing:

- a. *Student support to participate of experiential learning activities.* Most of our students depend on financial aid and work part-time either in restaurants and/or stores. Those experiences prepare them to work with people, and sometimes budget handling, but barely prepare them for their STEM career. Therefore, additional support will allow student to dedicate more time to their professional preparation. Funding could be used to support students doing research, internships, conversational English courses, professional workshops, participate of scientific meetings and prepare for graduate school tests such (GRE).
- b. *Research support:* HSI institution, such as UIAPR-SG, which is mostly academic, does not have faculty with research grants that provide support for students doing research, limiting the number of students pursuing this activity. Therefore, funding is needed to support those initial research efforts. Funding to support students doing research, acquisition of instrumentation and laboratory materials along with faculty incentives will help to increase the number of students doing research. The programs at UIAPR-SG, such as those from USDA-NIFA and Ronald McNair program, has helped to increase the number of students doing research, but those are limited opportunities.

- c. *Faculty incentives*: Full time faculty at UIAPR-SG may have academic load of 15 to 21 credits, with up to 7 different preparations per semester. That heavy load makes it very hard to do research, write grants and/or create new activities. Therefore, release time and financial incentives for faculty may help to increase faculty interest in research. Financial help to participate of professional conferences or scientific meetings is also an excellent way to entice faculty that creates new opportunities for our students.
- d. *Mentoring training*: Success of our projects has been because students belong to a group with mentoring that remind their great capabilities. Mentoring starts with our project director on campus, but soon and spontaneously, senior students become mentors of younger students. Mentoring training for other faculty, along with students, will warrant success and engagement of more students, and will prepare better leaders for the future.
- e. *Encourage collaborations – help to connect*: collaboration has been key in the success of our USDA-NIFA projects. Participating students have done summer internships as volunteers at collaborating institutions, but paid by our projects. Students get the research/professional experience from research institutions or established programs. And, those institutions get easy to train personnel to help with their projects. This has been one of the most sought-after activity of our USDA-NIFA projects, since students know they compete with their own peers, so feel confident about that.
- f. *Family involvement* – Family is a key element for Hispanic students. As expressed by Deborah Santiago in an article in the Chronicle of Higher Education “*Family is so important among Latinos that one-third of Latino undergraduates continue to live at home while they are enrolled*” (Santiago, 2011). That is usually the case for most of students at UIAPR-SG; family is a key element for students’ success. When I finally got one student to apply for a summer internship, and she was accepted, her parents would not let her go. So, the student asked for my help, and that is how I ended up in their house explaining to their parents about the opportunity. It was a success, and after the summer, her parents end up in my office thanking me. It was the first of many talks with parents. I had several students declining summer internship in USA because they care for a family member and could not find help for those two months. So, many times family is a key element for student engagement in extracurricular activities. IAUPR-SG provides parents with guidance about admissions and financial aid along with campus tours. That is how far we go, but our USDA-NIFA participants engage their parents when social activities and trips are planned. We recognized that family has been a key element in the success of our program participants. Including activities, where parents are invited, give them and the student’s security and confidence about the program, and the family is more engaged with student success.
- g. *Promoting entrepreneurship preparation* – One of the benefits of experiential learning opportunities, is that students learn to be independent and they are not afraid of new opportunities. Many students are looking forward to graduate and create their own business. Creating interdisciplinary activities, that combine science and entrepreneurship will prepare them for their future endeavor. Form our first round of programs one student set up her own farm and another started a cafeteria using locally grown products, of which she learned during our programs.
- h. *Inclusion of STEM future teachers*- Including opportunities for students in Science Education Bachelors programs will also multiply the effect that any STEM improvement program may have. Those future teachers with positive research, volunteer and professional experiences, are more likely to encourage their future students towards STEM careers.

Programs for Hispanic Serving Institutions that aim to get students more engaged with their own professional preparation will prepare passionate scientists, excellent professionals and future leaders.

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*Collaboration between Entrepreneurship and Sciences at the
Inter American University of Puerto Rico - San Germán Campus*

Vega-Rosado, Luz Leyda¹ and González-Mederos, Angela M.²

Summary and Recommendations

This paper summarized the experience of two faculty members, one from the Department of Entrepreneurial and Management Sciences Department and other from the Department of Biology, Chemistry and Environmental Science trying, for first time on campus, to provide students with activities that connect business and science. It presents the experience and interaction between students from entrepreneurship and sciences working for independent-interdependent courses taken in their respective departments. Resources are needed to allow growing tangible products from these interactions, not only providing reciprocal advice between students of science and entrepreneurship.

As suggested by the students, participants of the experience, and the two faculty members that developed it, the recommendations provided to National Science Foundation for the burgeoning HSI program are:

- Provide incentives to our students to stay on campus doing research and developing creative ideas to provide solutions to the economy and the business world. Most of our students in the Entrepreneurial and Management and Sciences Departments have full time academic loads along with part time jobs outside the University. That limits the time they dedicate to participate of activities such as research, conferences and workshops.
- Create opportunities to grow alliances on initiatives that already exists on campus such as the office of the Small Business and Technology Development Center (SBTDC) and the Center for Entrepreneurs Development. The SBTDC provides advice, by competent professionals, to new entrepreneurs that want to prepare a business plan for a business idea. Those new entrepreneurs could be students with real commitment to establish a business. The Center for Entrepreneurs Development is a relative new initiative that is beginning on campus that provides a space to have meetings and develop creative ideas. Our undergraduate students from different departments could benefit from this initiative.
- Funding workshops and conferences that prepare students from STEM areas with entrepreneurial and management knowledge, to reduce student stress about starting into a new area. Also, basic science workshops for entrepreneurial and management students, so they can communicate and interact with more confidence with scientists.
- Provide to our campus more research for STEM areas such as: agriculture, animal science, pathogens and to do market research in those areas. This includes materials, equipment, faculty development and incentives for students and faculty (assistantships, release time, respectively) to work in collaborative projects and translate a research study into a business plan or start up firm.
- Generate interactions with managers and entrepreneurs that received our students for internships. They could be approached to serve as mentors of the students to develop a real solution to the business world in areas related to STEM but at the same time with the entrepreneurial mind on how to add value and commercialize the solution.
- Leverage the relation that Dr. Vega-Rosado already established with more than one hundred family businesses in the country through research projects. These businesses are the ones who have the strongest roots and commitment with the country.
- Increase interactions with other educational institutions nearby, to exchange best practices and administrative procedures. These interactions may also allow students from different institutions participate of research and professional conferences in institutions other than UIAPR, increasing their network and knowledge.
- Develop flexible criteria to evaluate proposals from different institutions such as one like us that has less experience obtaining grants from National Science Foundation and less experience in applied research.

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***Collaboration between Entrepreneurship and Sciences at the
Inter American University of Puerto Rico – San Germán Campus***

**Luz Leyda Vega-Rosado, PhD
Angela M. González-Mederos, PhD**

The Inter American University of Puerto Rico (IAUPR) is a private institution with a Christian heritage and an ecumenical tradition. It is a non-profit organization founded in 1912 as the Polytechnic Institute of Puerto Rico by the Reverend J. William Harris. In 1944, the Institution was accredited by the Middle States Association of Colleges and Schools. It was the first four-year liberal arts college to be so accredited outside the continental limits of the United States. This accreditation has been maintained since then. The programs of the University are authorized by the Council on Education of the Commonwealth of Puerto Rico. IAUPR is the largest private university in Puerto Rico. Enrollment, in recent years, has been maintained at approximately 43,000 students. About 21 percent of all the Island's college students and 35 percent of the students who go to the Island's private colleges attend Inter American University. IAUPR has nine campuses led by Chancellors: the Aguadilla, Arecibo, Barranquitas, Bayamón, Fajardo, Guayama, Metropolitan, Ponce and San Germán Campuses; plus two professional schools: Law and Optometry. (Inter American University of Puerto Rico General Catalog 2015-2017).

The San German Campus of the Inter American University of Puerto Rico, where this project was born, is in the west side of the island. At present, it has close to 4,500 students, about 98% Hispanics and more than 80% receive federal aid to finance their studies. San Germán campus has vacant land that can be used for business projects dedicated to agriculture implementing knowledge from biology, chemistry, environmental sciences, entrepreneurship and management. The campus is located in a city with an unemployment rate close to 13% (US Department of Labor, Bureau of Labor Statistics, 2018). The city has facilities, which had been the headquarters for subsidiaries of big companies such as General Electric and Cordis. Now those facilities are vacant and could be used to stimulate entrepreneurial initiatives related to sciences and other STEM areas.

The students involved in this academic collaborative project are from two different departments. One group are seniors from a Bachelor's in the Business Administration (BBA) Program with a major in Entrepreneurial and Managerial Development. The other group are students in their second or third year from the Department of Biology, Chemistry and Environmental Science with concentration in biology or chemistry.

This academic project began in 2012 when doctor González-Mederos invited doctor Vega-Rosado to give a talk about Green Businesses for a Green Chemistry course. Dr. Vega-Rosado compared the twelve principles of the Green Chemistry and the sustainability of the businesses in terms of efficiency, cost reduction and competitiveness. She was inspired in part by the Sustainable Development Goals of the United Nations Organization, The Blue Economy promulgated by the economist and entrepreneur Gunter Pauli and by Cabri (2009), who recognizes that the violation of any of the twelve green chemistry principles determines the increases in the costs of the general entrepreneurial process. Dr. González-Mederos repeated the invitation to Dr. Vega-Rosado in 2016 and 2018. Since 2015, both colleagues were sure that it was necessary to develop some formal experience that linked entrepreneurship with science; the scientific world was crying out for it. Other Institutions have done that before (The University of Nottingham, The Royal Society of Chemistry, KKI Associates, and University of Edinburgh).

Both colleagues prepared a course syllabus for an entrepreneurial course designed for students from biology and chemistry programs. Dr. Vega-Rosado designed the course with the input provided from Dr. González-Mederos and the last one established the prerequisites and worked on the administrative process to make the course available and viable for the science students. It was included as a special topic in the curriculum of the Biology and Chemistry Bachelors Programs and so the Development of Businesses in Science elective course was born.

The official description of the course is *Study of the basic principles in the development and administration of businesses in industries related to science. Discussion of the aspects that distinguish eco-friendly companies and presentation of regulations on intellectual property in science.* Among the topics included in the course are the basis of business development and business administration; industries and businesses related to science, how to develop a business idea from science, how to turn the idea into a product or service; examples of sustainable and eco-friendly entrepreneurial projects around the world and intellectual property issues. This was also another opportunity to include Green Chemistry principles into business.

The course was taught for first time during Fall 2016. The statistics on the assessment of this course are presented in Table 1.

Table 1
Course: Development of Businesses in Science
August – December 2016

Students enrollment in the course	Students that finished the course	Grades distribution on the course	General average of student evaluation of the course
20	18 90%	A = 50% B = 39% C = 11%	3.92 (In a scale from one to four, being four the best.)

Sources: Electronic Gradebook and Faculty Evaluation by Students. Inter American University of Puerto Rico, San Germán Campus, (2017).

The first edition of the course (2016) was limited to the development of business ideas related to science, using the scientific method to develop those ideas. The second edition of the course, taught in the Fall semester 2018, includes a new interdisciplinary component: the interaction of students from business with students from science. Students taking the Design and Development of a Business Plan (ENTR 4400) course collaborate with our Development of Businesses in Science students. The Design and Development of a Business Plan (ENTR 4400) course is part of the graduation requirements for the students of BBA in Entrepreneurial and Managerial Development. Professor Vega-Rosado is teaching for both courses. She developed activities that require the interaction of students from both courses. The main activity is called “Reciprocal Advice”. This activity required that the science students develop a business idea and that the business students prepare a business plan that include a science component. All the students will receive a grade for the evidence of the reciprocal advice that they provide for each other. A minimum of ten contact hours during the semester are required between the students. The professor organized two integrative activities with the mixed students in one room. In the first one, all of them identified their entrepreneurial potential and in the second integrative meeting, we had an activity to stimulate creativity. The response from students of both Departments was very satisfactory after these activities. At this point it has been a challenge because is the first time that this interdisciplinary integration is developed on campus. This is an ongoing project at the time of the presentation of this paper. The results will be viewed on December 2018.

Projects presented and evaluated may develop new business ideas that will increase students’ experience. Therefore, funding is needed to provide more experiences to students that develop a business plan related to ideas provided from science and contribute to stimulate the economic development of the country. However, we can go further. We need to provide our students opportunities to start their business or to do at least a simulation to probe the viability of the business. Therefore, we need incentives to keep the students on campus working on their business-science plans instead of going to work in a fast food to complete their budget.

Resources are needed to provide release time for faculty from business and science to be guides or mentors of the students in projects related to STEM areas such as: agriculture, animal science, pathogens and to do market research in those and other entrepreneurial areas. Our previous relation with the business community, such as family businesses, warrants voluntary collaborations with established entrepreneurs, as mentors for our students solving a problem for the established business community, using the knowledge obtained at the University. Internships can also provide new experiences that translate into problem-solving opportunities for the business community, therefore funding for the students and faculty will warrant their commitment with the projects. Interactions with already established Small Business and Technology Development Center (SBTDC) and the Center for Entrepreneurs Development and with other institutions will also help to increase exposure and the student network, improving their communication skills along with their business and science experience.

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**6th National Forum on Entrepreneurial Education (NFEE)
Project Report - June 2019**

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Accomplishments

1. What are the major goals of the project?

The main purpose of the National Forum on Entrepreneurship in Puerto Rico is to provide an active learning space where researchers, professors and teachers can share and acquire the knowledge and tools to develop innovative and entrepreneurial (I&E) skills in their students, independently of the subjects that they are teaching. This is done by providing conferences, hands-on workshops, lessons learned panels and networking section focused on the major theme of the forum. The theme of the forum changes every year depending on what was identified as a necessity in the educators and researchers community.

A secondary goal is to connect researchers, professors, teachers and external advocates of I&E entities for future collaborations. Since the participants are from different private and public universities and schools around the island; NGO, gubernamental entities and private organizations participate to further their innovative and entrepreneurial skills in their workforce or to serve as presenters/collaborators of their different programs for the forum participants.

2. What was accomplished under these goals?

a. Major activities

On the 10th and 11th of June, 2019 the 6th National Forum was celebrated at the University of Puerto Rico - Mayaguez Campus. This year's theme was the Customer Discovery Process and each workshop and presentation had to incorporate an element of this process. Over 70 participants were present in this forum from different private and public universities, schools and external organizations, such as: USTPO, Echar Pa' Lante (I&E coalition movement), PRTEC (Incubator), Department of Education (Government Agency), Colmena 66 (Part of PRTRUST (Puerto Rico Science Technology and Research Trust), etc.

During both days of the forum, 15 presenters had the opportunity to share hands-on workshops in subjects of SBIR and Intellectual Property, lessons learned on Customer Discovery Process Programs, model programs developed to promote the I&E in their universities, as well as tools and opportunities available through the P.R. ecosystem. A networking session that included poster presentations and showcases by undergraduate and graduate students was done on the first day with the goal of connecting the participants and catalyze collaborations. After each presentation an evaluation, using Google Forms, was sent to all participants so they could give feedback to the presenters. This information was made



available to each of the presenters for future reference. In addition, the participants fill out a general evaluation for each day for future reference and feedback to improve the forum next year.

b. Specific Objectives

The specific objectives were:

- 1) Provide space to share active learning techniques and tools for professors and teachers.
- 2) Expose professors and teachers of any discipline to entrepreneurial topics that can be applied in their classrooms.
- 3) Provide a platform for the exposure of new efforts that are taking place to help accelerate the innovation and entrepreneurial ecosystem in Puerto Rico.
- 4) Identify new tools that can be applied for professional or academic purposes.
- 5) Connect professors, teachers and external allies for future collaborations.
- 6) Expose professors and teachers to I&E research and project around the island.
- 7) Certificate professor in subjects of I&E by the Center for Professional Enrichment (CEP)

c. Significant Results

1. The customer discovery process is of high importance when building partnerships in the university system as demonstrated in Dr. Rodolfo Romanach presentation titled “Customer Discovery in Building Industry-University Partnerships”. To achieve Economic growth it is imperative that we first understand what is needed to stimulate financial and academic progress in our educational system. To do this, collaborations are crucial, not only between universities but also with industries that can assist students as learning hubs by providing resources and mentorships.
2. In this forum, we also wanted to present programs and tools that could benefit the participants. It is well known that funding is essential to develop any type of entrepreneurial agenda and this is where Dr. Jaime Santiago, a frequent SBIR reviewer, focused his workshop titled “Looking for Entrepreneurial R&D Funding? Key issues when drafting an NSF-SBIR proposal”. The Small Business Innovation Research (SBIR) program of the NSF has the objective of supporting new companies and entrepreneurs to transform ideas into products and/or services. Not only does this program provides funding, but it also comes with a network of people committed to mentor new entrepreneurs in their new ventures. Our participants had hands-on experience in developing an SBIR proposal by learning through examples that included the different segments that are required to complete the applications.
3. From the offices of the United States Patent and Trademark Offices (USTPO), Jorge Valdes and Juan Valentin, in collaboration with the UPR intellectual property director, Yahveh Comas, gave a dynamic workshop about protecting ideas and products. The objective of this workshop was to raise awareness in the community about the different strategies that exist to protect ideas when doing a customer discovery process. The presentation ranged from protecting ideas at a high school level to university and professional level.



4. One of the major challenges teachers and professors are undertaking is the lack of motivation from the students and the need for dynamic methods to capture their attention. Dra. Mitza Soto has developed a new type of teaching method that uses an immersive role-playing escape room. Each student assumes a role and in order to escape successfully the room assigned, they must learn to work together. It is a powerful tool to use as icebreakers and bonding in classrooms and even professional settings.
5. Psychology plays a major role when interacting with potential clients, which include the use of body language and listening skills to connect in an active and emphatic way. Dr. Marielí Ríos Pérez understands that entrepreneurs are creative strategists and innovators that need certain skills to be successful, but in some cases, some cognitive and emotional factors can affect the process of connecting with potential clients. In her presentation, Dr. Ríos gave tips and tricks to overcome barriers of communications and how to understand the needs of the client by being empathic.

3. What opportunities for training and professional developments has the project provided?

This forum gives teachers and professors the opportunity to learn about different entrepreneurial subjects and skills that can later be transferred to students in their classrooms. A certificate from the Center of Professional Enrichment (CEP) is given to all the participant for the contact hours. The CEP's sole purpose is to provide the necessary tools to create well-prepared and highly motivated individuals that can contribute to the community. The National Forum is considered a certified tool for the professional advancement of individuals in the educator community.

The forum also provides an opportunity for professional growth to all its presenters, since the participants evaluate each one right after presenting. This gives the necessary feedback to help them improve for future presentations. The organizing team is composed of graduate and undergraduate students that help in technical support, registrations, collection of data, logistics of the event and organization of presenters. This opportunity helped students develop project management skills as well as teamwork abilities.

4. How have the results been disseminated to communities of interest?

The material used as a resource for each of the workshops and presentations were collected in a digital form to be shared with all the participants via email. The shared resources include all powerpoint presentations, important guides that were provided by the USPTO, step-by-step guides to recreate the escape room exercise and the contact information for future collaboration or questions. Also, all the material shared should be posted in the toolbox for educators in the website of one of our major collaborators, the Business & Economic Development Center (BEDC) at the University of Puerto Rico, Mayaguez campus <http://cnde.uprm.edu/>

A poster presentation of the forum was developed that was presented at the Network and Exposition section that took place during the forum. The objective of this was to present the benefits of the forum and introduce a model that could be replicated by other universities or entities to help further entrepreneurial education in their sector.




5. What do you plan to do during the next reporting period to accomplish the goals?

Our goal of producing a model of the forum that could be replicated by other universities or entities is being written in the form of an informative paper. During this period, before celebrating our next forum, which will take place during next summer, we plan to write and publish this paper and be present its various activities and conferences to offer our help to bring the forum to a larger community.

The organizing team of the forum also will be working to find new resources for the next forum, which will take place next year, for dynamic workshops that are focused on developing an entrepreneurial skill.

Participants/Organizations

1. What individuals have worked on the project?

Name	Role
Dra. Moraima De Hoyos-Ruperto	Chairman
Angelisse Ramos	Lead Organizer
Glennys Rivera	Certification manager
Jahannie Torres	 Technical Support

Full details of individuals who have worked on the project:

Dra. Moraima De Hoyos-Ruperto

Email: moraima.dehoyos1@upr.edu

Role: Chairman

Contribution to the project: Responsible for overseeing and coordination the whole activities of the forum, including the selection of the themes and speakers.

Angelisse Ramos

Email: angelisse.ramos@gmail.com

Role: Lead Organizer

Contribution to the project: Organizer of the logistics of the forum including presentations, breaks and managing of support staff.

Glennys Rivera

Email: glennys.rivera@upr.edu

Archived in DSpace and assigned the identifier: <https://hdl.handle.net/20.500.11801/2528>



Role: Certification manager

Contribution to the project: Process of certifying the participants with the Center of Professional Enrichment and ethics hours.

Jahannie Torres

Email: jahannie.torres@upr.edu

Role: Technical Support

Contribution to the project: Aid the presenters in organizing their presentations and materials to ensure quality deliverance during the forum.

What other organizations have been involved as partners?

1. NSF-HSI Conference –UPRM: On November 8 & 9, 2018 the University of Puerto Rico-Mayagüez (UPRM) hosted the HSI Conference: Accelerating the Impact of HSI STEM Education and Research on Innovation Ecosystems, in cooperation with other HSIs, as well as partners in the commercial economy. The conference provides input to NSF on how to expand active learning opportunities for undergraduate populations at HSIs by linking these students with mentors from both the commercial and knowledge economies.
2. Business Center and Economic Development at the University of Puerto Rico – Mayaguez Campus: This center promotes the development of an entrepreneurial ecosystem that mobilizes the multidisciplinary human and technical resources of the University of Puerto Rico system to stimulate innovation, entrepreneurship and economic growth.
3. UPRM E-SHIP Network: A network made up of students and professors at the University of Puerto Rico – Mayaguez Campus (UPRM) as well as emerging entrepreneurs from different parts of the island who share a commitment to creating opportunities of collaboration and networking between innovative minds.
4. USPTO: The United States Patent and Trademark Office (USPTO) is the federal agency for granting U.S. patents and registering trademarks.
5. UPR- Office of Intellectual Property: Is the office at the UPR that supports any effort of collaboration among academic, government and the private sector regarding ownership, patenting, licensing and protection rights to investors.

What other collaborators or contacts have been involved?

1. Echar Pa' Lante: A movement committed to promoting new projects that open possibilities for the future of all Puerto Ricans. It promotes a better quality of life, education, and entrepreneurship, among other initiatives, as a means of improving socio-economic challenges.
2. Colmena66: Local referral network that connects entrepreneurs and merchants with more than 100 non-profit organizations, academic institutions, government agencies, among others, that provide services and help to the entrepreneurs.



Impacts

1. What is the impact on the development of the principal discipline(s) of the project?

The forum has helped build a community of researchers, educators, mentors, and professionals that seek to develop innovative & entrepreneurial skills in their respective areas of work. Based on the evaluations done by the participants it was commented that the skills learned in the forum would be applied in their classrooms, personal projects, and workspace. One of the participants commented:

“I will constantly use them in my daily work, connecting entrepreneurs with the resources they need to start or grow their businesses”

Translated from Spanish

The technique presented by Dra. Maritza Soto, which consisted of an escape room game, is being considered to be implemented in some entrepreneurial courses to help develop teamwork among the students. Also, collaborations with entities such as Echar Pa’Lante and Colmena66 have emerged to help some of the participants bring to their schools, universities or workplace different workshops and conferences to further the entrepreneurial agenda.

2. What is the impact on other disciplines?

The forum has strengthened collaborations between the UPRM E-SHIP Network and other universities and external entities such as Echar Pa’Lante, Colmena66, United States Patent and Trademark Office (USPTO). Collaboration between the UPRM E-SHIP Network and other universities is crucial for the development of entrepreneurial education throughout the island by sharing replicable models that can be implemented in their establish curriculums. Similar, the collaboration with external entities helps in the development of resources that could be used by our students and entrepreneurs.

3. What is the impact on the development of human resources?

The forum offers a unique opportunity for educators to further their education in entrepreneurial subjects at no cost. Also, the forum provides key ideas that can be modeled by other entities or universities to create or improve their ecosystem, which consequently will provide opportunities for students and faculty to acquire new skills. Ultimately, this benefits larger scopes such as economic and educational at a national level.



A Four Level View of Industry University Collaboration

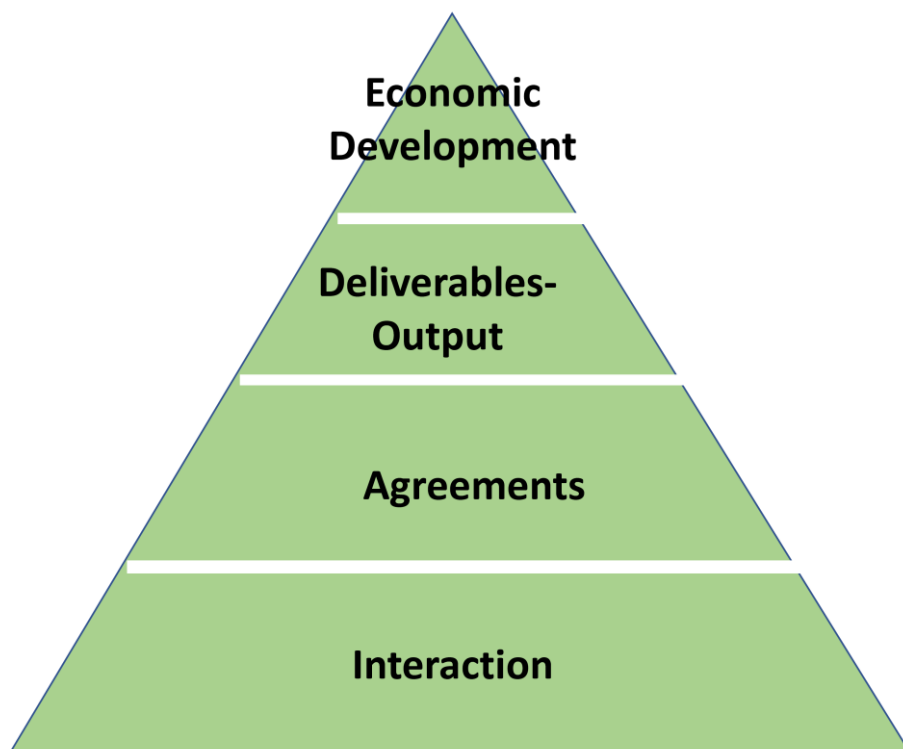
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Introduction

One of the priorities of the Hispanic Serving Institutions programs is to inform on the design of the HSI program including opportunities for building innovative cross-sector partnerships. This contribution describes a view that has emerged as the result of many interactions with industry and also as a reflection of 20 years of industry-university collaboration at UPR-Mayagüez.

Proposed Approach

This four level view is easy to visualize and also shows the progress that may be achieved through collaboration. Figure 1 show this image:



Interaction

Every year close to 500 students from the School of Engineering participate in the COOP program; a six month industrial immersion. About 65% accept positions in the island, and 35% accepting

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opportunities in the mainland states. Industry is where students receive their COOP opportunity and obtain employment after graduation. UPR-Mayagüez has a strong interaction with industry through its COOP program. Industry is where we can find many of our former students. Professors that visit an industry will soon start recognizing many of their former students. Thus, every professor has contributed to that industry that is often seen as separate or distant. Every professor is part of industry through the contributions of their former students. Interacting with industry is doing a reverse homecoming day, where the professor visits former students.

Industry may be defined as a distinct group of productive or profit making enterprises. However, industry should not be seen as different from the University. Industry and University are highly correlated through the COOP program and our former graduates.

The best way to start interacting with industry is to communicate with former students or with industrial scientists you met at a scientific meeting. Professors should stay connected to their former students through LinkedIn, ResearchGate or other suitable media.

The first recommended step is to request a visit to the company and bring some students. These could be students from a class that the professor is teaching, or from their research group. Companies are usually very interested in collaborating in this manner. The professor should prepare for the visit by obtaining information on the company through its web site. During the visit:

- Do not ask about the companies' problems or difficulties. Focus on listening and understanding how the company works. Allow time for the company to establish trust and initiate discussion of their challenges or difficulties.
- Avoid constantly emphasizing the importance of your research. Focus on understanding the companies' operations.
- Do not speak about problems that you solved at another company. This may give the impression that their information will not be secure with you.
- Do not ask to take photos during visits to the plant.

The author's experience is that professors need to be careful with the word "research". They will also find many industrial contacts who see research as an intellectual pursuit by academic researchers about subjects that are not relevant to an industry. Professors need to keep in mind that research is the systematic investigation to establish facts and reach new conclusions. The same well designed experiment can provide relevant information for industry, while also exploring fundamental scientific concepts. The same well designed experiment trains a student to use a systematic approach to solve the industrial problems after graduation. We will need to patiently emphasize the importance of research in the training of scientists that will be able to address complex industrial processes.

Professors will also meet industrial contacts who only want to receive students for COOP opportunities. This is a good opportunity to start a conversation by stating: "What are the skills that these students should have?, What are the weaknesses in their training that we need to address

at the University”, and eventually follow-up with “perhaps we can develop a project such that I can send you more well-trained students in the future who will be almost ready to contribute”.

Interactions are also possible through meetings organized by societies such as the American Chemical Society, Puerto Rico College of Chemists, and other groups which are regularly attended by industry personnel. There are also groups such as INDUNIV (Industry University & Government research consortium) that sponsor industry-university interactions. These examples are specific to Puerto Rico but similar groups likely exist near all HSI. The author’s first industry research projects were through INDUNIV and the Dane O Kildsig Center for Pharmaceutical Process Research. Both groups have industrial members that provide funding for research projects that are of interest for multiple companies. The professors then submit proposals, receive industrial feedback, and finally funding.

Agreements

Interaction is essential is to find a group within the company that needs the services of the University. Professors need to understand that most companies do not have research program managers like NSF, NIH, or other government funding agencies. They may have a person in charge of community relations or University relations. These persons may be helpful in development and agreement, however, they are usually not the ones that need the services of the University. The purpose of the interaction step is to identify the industries needs and a project champion who will dedicate time to develop a request for service or scope of work document.

Once a project is defined, the company may issue a request for service or scope of work document. Regardless of whether it is called service or research, new knowledge is gained through a systematic study. The researcher needs to make sure that the industrial contact knows how to provide funding for the project. Unfortunately, there are many cases where the industrial contact has a great idea for collaboration but does not know how to gain the approval of management at the company.

Manufacturing

Companies in Puerto Rico are focused on manufacturing. Manufacturing integrates many disciplines, requiring teams from the multiple academic programs at Puerto Rico’s Universities. Manufacturing currently represents 47.2% of Puerto Rico’s Gross Domestic Product, which reached a total of \$101.1 billion dollars in 2018.¹

The manufacturing sector of the island provides more than \$3 billion in direct contributions to Puerto Rico’s treasury, including Act 154, which reached in Fiscal Year 2018 a total of \$1.9 billion of dollars, approximately one-fifth of the \$9.3 billion General Fund Net Revenues (Act 154 is the 4% tax on foreign corporations with sales of more than \$75 million approved on October 25, 2010).² However, the maintenance and growth of this economic sector has relied heavily on tax incentives, which are not indefinitely sustainable. Puerto Rico had over 140,000 direct jobs in manufacturing 20 years ago, but now has about 73,000 jobs³ with 215,000 indirect jobs and a total

of 323,000 direct, indirect and induced jobs.⁴ This change is related to several factors, including the uncertainty of manufacturing orders which has moved many companies towards the use of a temporary or contract personnel. About 14,000 of these jobs are in pharmaceutical manufacturing.⁵

Thus, one of the difficulties for an industry-university project collaboration with local manufacturing companies is that the cost of the project could be charged to the cost of product. The company could be reluctant to approve the project if it contributes to increasing the cost of the product, even if this increase is minimal. Thus, they may seek to include the project as part of the budget for the introduction of a new product to the plant. The project will be part of a capital project that covers the cost of a new product. The researchers may need to wait several weeks or months for this to occur. This type of project has a limited duration, and the researchers will need to complete the project within the specified time frame. The university will also need to send an invoice for the project cost in timely fashion.

The professors at the University are frequently not aware of the many opportunities to advance science and technology through collaborations in manufacturing. Manufacturing is often seen as routine work. The definition of manufacturing can be as simple as “making things”.⁶ However, manufacturing can also be defined from both technological and economic points of view. The technological definition is “the application of physical and chemical processes to alter the geometry, properties, and/or appearance of a given starting material to make parts or products; manufacturing also includes assembly of multiple parts to make products.”⁶ These transformations require knowledge of chemistry, physics, biology, and geology in the case of mining (or obtaining water for manufacturing processes). Manufacturing requires the challenging integration of a number of disciplines of study, which are often separate departments and research groups at the University.

Manufacturing also requires a sequence of operations, with these operations bringing the material closer to the desired final or commercial state. Manufacturing also has an economic definition. Manufacturing is the transformation of materials into items of greater value by means of one or more processing and/or assembly operations. Research is needed in improving manufacturing processes. For example, the need to improve pharmaceutical processes has been described in numerous articles and even regulatory guidances.⁷⁻¹⁰ The National Governors Association has recognized the importance of manufacturing and stated the need to move from “let’s save manufacturing” to “let’s lead in what lies ahead”.¹¹

Manufacturing companies can fund projects at the University. However, there are often substantial differences in the contracting procedures followed by the company and University. There are companies that do not want to see the term “indirect costs” in their proposal. They are not against indirect costs, they are simply not familiar with them. In these cases it is best to provide a project service cost, and the schedule of payments to the University. An itemized budget but with the indirect costs already included in each item is usually preferred. The itemized cost for support from a student or professor will include the indirect costs. In the same way that a company vendor does not include the profit margin in a service proposal, there is no need to separately indicate the indirect costs. The professor provides the budget as requested by the company, but provides an internal approved budget to University administrators. This internal budget is used for student

stipends, faculty payments, establishing the indirect costs, and the acquisition of any needed supplies throughout the project, and is not shared with the industry.

The project could occur with a student acquiring data at the company and analyzing it at the University under the supervision of the professor. This approach often facilitates the research as the company may already have the equipment and facilities. The company is well familiarized with their product and will instruct the student on the necessary safety procedures to handle their materials. This approach provides more exposure to the student to the industrial environment, and avoids the need for transferring materials to the University. This research could be classified as off-campus research, and require a lower indirect cost rate. The indirect cost rate needs to be discussed with the research office at the University.

However, if a project is approved, this will likely result in a purchase order being issued to the University. The University becomes a vendor within the companies purchasing system.

Deliverables-Outputs

Industrial contacts will show a lot of interest in students, and usually want students to present the results. They value having access to students who have expertise in specialized equipment, skills, and research. Professors have to provide students with the opportunity to present in meetings with the industrial sponsors. They will receive questions such as: “Why do you think this is occurring?”. They want to see the student’s ability to think and explain their knowledge. Students need to understand that the project is an extended job interview. The project allows the industrial contact to get to know the student, and evaluate how they would perform in an industrial scenario. An impressive presentation will often be followed by the question: “when did you say that you are graduating?”, even though the student did not mention graduation.

Industrial contacts are very interested in the science as well as the results (possible benefits to the company). They want the project to evolve under as a well-organized scientific study, and hire scientists trained under academic rigor. Publications are also important to industry, because they show that the student’s research was evaluated by peers and found to be scientifically sound. Industrial scientists want to see students trained under a rigorous scientific program. Publications indicate that a student was trained under a rigorous research environment. However, if the publication involves an industrial process it must be evaluated by the companies’ legal advisors before publication.

The researchers must seek the companies’ permission to publish any findings of the study. The industrial contact should be one of the authors due to their contribution to the design of the study. The research is also an opportunity for professional growth for the industrial scientist. For many industrial scientists, this will be one of the few opportunities that they will have to publish while working in industry. The industrial contact is then charged to obtain the approval from the legal team. The time needed will vary from company to company, and may be as short as one week in many cases if the product name is not mentioned. This should not be a problem as many journals now accept studies where the name of a proprietary product or molecule is not mentioned.

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However, it is not necessary to wait until the time that a manuscript is ready for publication to obtain permission to share the information obtained in the study. The researchers may seek the companies' approval to present at scientific meetings as the project progresses. These permissions to present are an opportunity to become familiarized with the companies' procedures and possible publication concerns. If the results described in a manuscript are the same that were approved for presentation in past scientific meetings, then it may not be necessary to seek additional permissions to publish. The researchers should always check with the company, but the approval of the manuscript should be easier when the results have been presented in scientific meeting previously in this situation.

There are many journals that accept publications based on a proprietary drug or product where the entire set of components is not listed. Researchers should become familiarized with the companies' prior publications, and how these protected sensitive proprietary information.

The author has been told that scientific publications often influence the regulatory decisions of government agencies. Many companies like to see academic publications that show how current processes can be optimized through new technology or novel strategies. These publications are often referenced when a company improves a process. Many companies prefer to see the academic paper published first, before they invest on new technology and seek regulatory approval.

Economic Development

One of the significant challenges of our Universities is to contribute to economic development in our island. However, many of our graduates obtain jobs elsewhere. The author recently received the following feedback: "I am happy that my son completed his engineering degree at Mayagüez. But he is my only son, I really wish he was working in Puerto Rico instead of Seattle."

Our universities have many opportunities to contribute to economic development through the diverse research and scholarship areas at our institution. The concept of the innovation ecosystems discussed the NSF Engineering research centers provides this vision: "An important feature of an innovation ecosystem is that the resources available to the knowledge economy are coupled to the resources generated by the commercial economy, usually as some fraction of the profits in the commercial economy. Another feature is that the ecosystem is usually strategically developed around a specific technology."¹² Each research area at a university represents an opportunity to contribute to economic development.

The entrepreneurship activities that are being sponsored by multiple organizations are essential to generate the economic development to maintain talented graduates in our island. The entrepreneurship efforts involve several HSI in the island including Universidad del Turabo, Inter American University and Universidad del Sagrado Corazón. These efforts include increasing the number of submissions to Small Business Innovation Research (SBIR) grants, which has been typically low. The Puerto Rico Science Technology and Research Trust has been leading this effort in recent years along with the Guayacan Group, and the Business and Economic Development Center at UPR-Mayagüez. These two groups have teamed with the Georgia Tech Venture Lab for I-Corps trainings.

I-Corps trainings have served as a meeting place for the commercial sector and HSI. Students and professors have had the opportunity to work with investors, and business development specialists. A number of our professors, have participated in the active learning based I-Corps.¹³ I-Corps started in January 2015, and now a 9th I-Corps is being organized for October 2019. An I-Corps sites program is now running at UPR-Mayagüez.

The Department of Economic Development has also established a program for expansion of small and medium sized companies some of which are based on science and technology developed at academic institutions in the island. For example, MBQ Pharma a locally created company based on research by several professors at the Medical Sciences Campus to prevent metastasis in cancer patients.¹⁴ Many of the small and medium sized companies are related to manufacturing or food processing and could grow through interaction with HSI.

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