An Industry-Academy Partnership to Bridge the SES Gap in Engineering Education

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Abstract

The prevalent gap between students from different socioeconomic statuses (SES) affects multiple aspects of our social functionality. Among its effects, the SES gap directly impacts the opportunities to which students have access while in college and beyond. This paper discusses the efforts and partial results of a program aimed at bridging such differences for low-income, academically talented students (LIATS) in a Hispanic Serving Institution (HSI). The reported approach leverages the relations with a group of industry partners to provide LIATS with scholarships, professional mentorship, workshops, and on-the-job training opportunities while sharing with the industry the students' e-portfolios, professional profiles, and resumes, developing a symbiotic relationship where both benefit. After three years of interactions, the results show how these opportunities helped LIATS develop their skills, leadership, and competitiveness as future STEM professionals. The experience also demonstrates that professional growth opportunities are critical for engaging LIATS in real-life contexts where they collaborate and interact with industry partners, and for providing them with opportunities that help to bridge the SES gap.

Keywords— *Hispanic Serving Institutions, Industry-Academy Partnership, Low-Income Academically Talented Students*

I. Introduction

Educational research has widely documented the achievement gap between students from different socioeconomic statuses (SES) [1], [2]. At the college level, this gap manifests among students from lower SES with a higher attrition level, longer times to graduate, and lesser post-graduation opportunities than those with a higher status [3]. For the last four years, an initiative sponsored by the National Science Foundation in the College of Engineering (CoE) of the University of Puerto Rico Mayaguez (UPRM), the Program for Engineering Access, Retention, and LIATS Success (PEARLS), has implemented strategies to address the SES gap among low-income, academically talented students (LIATS) [4]. PEARLS builds upon a series of interventions organized around a theoretical model named the LIAT College Access and Success model (L-CAS). The L-CAS is a hybrid model that combines elements from Lent's Social-cognitive Career Theory (SCCT) [5] and Tinto's Departure Model (TDM) [6] to provide students with a set of institutional experiences designed to drive them to successful engineering careers. The SCCT components of the L-CAS model were the focus during the early stages, while TDM's components were emphasized during the later stages of their academic endeavors. L-CAS TDM elements were poised to create the backbone for intervening LIATS with an institutional component that provided them with tools for interactions with faculty and staff, extra-curricular activities, peer group interactions, and formative-growth experiences. We hypothesized that the combination of these elements would impact LIATS' academic performance, career choices, and institutional experiences in a way to drive their actions to complete their engineering degrees on time and become successful STEM professionals. This paper presents the efforts and partial results of a partnership with industry that has been pivotal for growing LIATS' skills for competitiveness as future STEM professionals, developing their leadership skills, and providing them with opportunities to engage in industry and research experiences as a strategy to bridge the SES gap.

II. Engineering PEARLS at UPRM

The academic setting for the presented practice was the University of Puerto Rico Mayaguez (UPRM), a Hispanic Serving Institution (HSI) part of the state-supported University of Puerto Rico (UPR) System. With 10,949 students in fall 2022 (23.3% of the system's student body), the host is the largest unit in the eleven-campus UPR system [7]. The College of Engineering (CoE) in the host campus serves 4,936 students, 94% of them distributed in nine academic programs at the BS level, and the remaining 6% in master's, and Ph.D. levels. For many years the UPRM has maintained a prominent position as one of the largest providers of Hispanic engineers in the US, graduating yearly more than 500 new engineers, from which approximately one quarter are females [8]. The CoE offers five-year academic programs in Civil, Electrical, Computer, Computer Information Science, Industrial, Mechanical, Chemical, and Software Engineering.

For a long time, CoE-level statistics have shown a persistent gap in achievement levels attained by students coming from different socioeconomic groups. Students from low-income households graduate at rates up to 20% lower than those from middle- or above-income levels. Similar disparities also become apparent in retention and persistence rates, and time to graduation [7].

The Program for Engineering Access, Retention, and LIATS Success (PEARLS) was developed as a college-wide initiative to impact observed trends, establishing a set of institutional interventions aimed at increasing success statistics of low-income, academically talented students (LIATS) [4]. The interventions were longitudinally organized around five major areas that include background experiences, student sense of belonging, formation, growth, and graduation.

Interventions in the area of background experiences aimed at having a diverse group of students participate in the program. The interventions to reinforce the sense of belonging among students included the creation of learning communities, peer-mentor support, courses, and talks aimed at strengthening the self-efficacy beliefs and outcome expectations of students. Formative interventions included training to grow professional skills and leadership. Growth interventions, the focus of this work, encouraged LIATS to take actions directed at participating in undergraduate research, industry experiences, and leadership roles [9]. The last intervention stage, graduation, guided students on leveraging their college experiences for competitively entering either graduate school or the engineering workforce. Ninety-two students enrolled in PEARLS in year one, distributed in four cohorts that included 34 in first-year, 28 in the second year, 28 in the third year, and two graduate students. Of these, 57% were males, 70% came from public schools, and 88% came from families with less than $30,000 of yearly income.

A. Industry-Academic Partnership Model

Experiential learning is an essential aspect of engineering education, providing students with hands-on experience in applying theoretical concepts to real-world problems [10]. However, it can be challenging for academic institutions to offer such opportunities within the confines of the classroom. Therefore, an industry-academic partnership becomes an effective approach to enable engineering students to gain practical skills and knowledge, a key element of the growth intervention phase within the Tinto's Departure Model.

Different forms of industry-academia collaborations (IAC) have developed over time, in different places and disciplines, pursuing various objectives [11]. Cooperative Education programs, for example, seek to provide students with experiential learning and have been a successful model adopted in many universities. Similarly, work-study programs, internships, and capstone courses, among other forms, all provide some form of experiential learning for students. Other IAC forms have been documented to support research, technology transfer activities, or access to human resources for certain activities [12] .

Despite the various initiatives, a standardized scheme to support IAC interventions going beyond the traditional COOP model is hard to establish, as most interaction models strongly depend on individual efforts between particular institutions and specific industries. In PEARLS, we introduced a custom IAC scheme to promote experiential learning for engineering students that can be deployed at a larger scale within UPRM and across other universities to enhance the formative-growth stage of the L-CAS model.

PEARLS interventions were designed to address the needs of our LIATS in stages as described by the L-CAS model. During the growth phase, students sought professional mentorship to guide their future roles in the workforce, therefore, opportunities such as industrial and entrepreneurship enlightenment were crucial. An industry alliance was pivotal for growing LIATS skills for competitiveness as future STEM professionals. They enabled the development of leadership skills and provided them with opportunities and experiences as a strategy to bridge the socioeconomic status (SES) gap. To enable the growth phase interventions within our model, a systematic framework of the stakeholders was needed. PEARLS industrial partners were engaged through the industrial advisory board of the UPRM College of Engineering. The benefits derived from this synergism included partial funding for selected activities, professional mentorship, workshops, and on-the-job training opportunities for LIATS, while the PEARLS program shared with industry partners students' professional profiles, granting them access to the student's e-portfolios, and disseminating, among students, information about opportunities in their organizations, enabling mutually beneficial alliances.

The Industry-Academy Partnership was designed based on the domains of the industry-academic collaborations enabled by memorandums of understanding (MOUs) [13] as depicted in Figure 1.

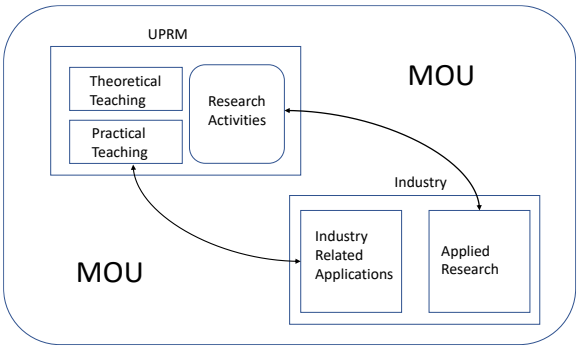

Figure 1 Domains of the Industry-Academy Partnership.

The Academy domain was comprised of the competencies of the university setting, where professors leverage classical theoretical courses to teach the fundamental concepts with complementary practical sources such as special projects and professional electives. The combination of these experiences provided the basis for undergraduate research activities. However, in order to guide these experiences into the applied realm, industry partners were much needed. Hence, the industry domain enabled the realization of such called "real life" necessities or applications, that when connected to the practical teaching aspects of the academy were poised to produce life-changing experiences for the students. Similarly, the industry needed research and development activities but was not necessarily geared towards those activities, therefore combining the need from the industry with the knowledge from the theoretical and research activities at the university become a powerful tool for success. The model presented in this article provided the means to connect these two domains via collaborative agreements and MOUs that have proven to be a valuable mechanism for the enhancement and continuous support of this partnership.

LIATS were provided with skills developed during the belonging and formative stages of the L-CAS model, while industrial partners brought the "real world" context and experiential learning opportunities in a collaborative scheme geared towards a win-win scenario. This partnership enabled crucial professional growth opportunities for engaging students in real-life projects where collaboration and interactions with industry partners led them to develop industry experience. They also grew their communication skills and teamwork abilities in work settings and ultimately provided them with opportunities that helped to bridge the SES gap. Figure 2 shows a diagram of the Industry

Academy Partnership developed at UPRM where the roles and responsibilities of all parts are presented [14].

As part of our work in progress, we also established an information flow supported throughout a project web page that allowed each player to provide information and access critical data needed for their roles. The project management level established the channels to communicate with the system administration, students, mentors, and industry liaisons. System administrators managed the access and contents structure of the web page and data repository. Students provided their resumes and e-portfolios, while also having access to them. Company liaisons had access to resumes and e-portfolios while also providing information about open opportunities in their organizations. Mentors provided students with advice and awareness about opportunities and how these matched their interests.

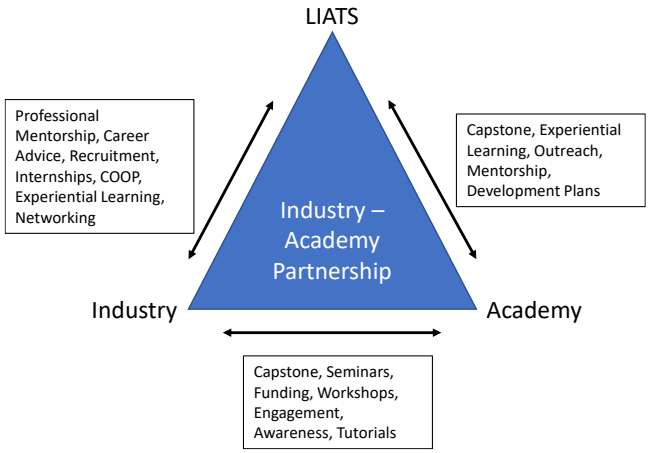

Figure 2 Diagram of Industry-Academy Partnership

The web page and social media maintained public information about students, partners, publications, and activities. Our information manager had access to student records, mentors, and industry documents and fed information to the web page management and social media updates. Figure 3 provides a view of the information flow model used in the project.

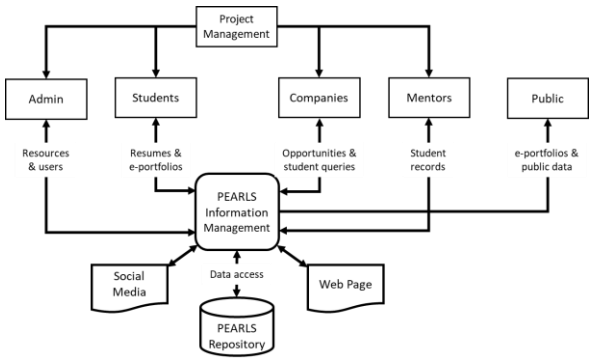

Figure 3 Top-level view of information flow.

Our ultimate vision and part of our ongoing efforts are consolidating this model into a computer-based information management system that can evolve with the project. The rationale behind this scheme is to promote communications for the industry-academic partnership so that our students could access more and better opportunities in areas of common interest.

III. Results

The Industry-Academy Partnership developed and presented in this work has demonstrated to be a well structured engagement mechanism to support the growth intervention phase of our L-CAS model. Industrial partners gained guaranteed access to pre-qualified LIATS, whereas the academy gains a portfolio of industrial opportunities that can be offered to students with different backgrounds and interests. This systematic framework, as shown in figures 2 and 3, has proven to be crucial for the latest stages of our LIATS before graduation.

L-CAS, as a hybrid model that combines elements from Lent's Social-cognitive Career Theory (SCCT) and Tinto's Departure Model (TDM), required well designed interventions along the LIATS evolution during their path. SCCT activities were structured within the curriculum, however the growth portion demanded extracurricular activities that tend to be complex and dependent upon external resources. In this case, our Industry-Academy Partnership scheme attracts the participation of companies by guaranteeing priority selection among the pre-qualified LIATS, while the University secures options for the students. With this mechanism in place, we were able to fulfill the demands of this critical phase of our model.

So far, dozens of PEARLS students have been approached by recruiters considering them for industry experiences and opportunities. Data from the third-year show that 63% of PEARLS students have completed work experience as interns or COOP, while 44% reported participating in research opportunities. Furthermore, 18% of students presented their works in virtual scientific-professional conferences or meetings, 42% received recognition for their work, and 52% played leadership roles in student or community groups. These results show that given the right formation and with the proper liaisons, students, regardless of their SES background, will embrace professional growth opportunities and engage in real-life contexts where collaboration and interactions with industry partners lead them to develop experiential skills as practitioners in work settings and ultimately provide them with opportunities that help to bridge the SES gap.

IV. Conclusions

After three years of interactions, the industry-academia collaboration model developed as part of PEARLS has enabled an ecosystem of interactions that have benefitted all players: students, the university, and industry partners. Students have been impacted with opportunities to acquire work experience, cultivate their professional skills, and grow as future STEM professionals. The university, through PEARLS, has advanced its mission of forging professionals able to respond to the needs of our industry constituents, while also addressing its social role of educating and preparing competitive professionals. Industry partners have benefited from the talent of well-prepared professionals to fulfill their human resources needs and be able to reach their organizational goals. The sum of all the above has created bridges above the SES gap that demonstrate that it is possible to establish sustainable strategies to grant access, equity, and inclusion to all segments of our students to growth and development opportunities.

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