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# Assessing the Effectiveness of The LIAT College Access and Success Model (L-CAS) on Low-income Hispanic Engineering Students (Experience)


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Aidsa I. Santiago-Román is a Professor and Chair of the Department of Engineering Sciences and Materials at the University of Puerto Rico, Mayaguez campus. She has a Ph.D. in Engineering Education from Purdue University and Bachelor’s and Master’s degrees in Industrial Engineering from the University of Puerto Rico- Mayaguez (UPRM). At UPRM, she has won many awards, including Distinguished Professor, at the Engineering Sciences and Materials Department in May 2019. She is the founder of and advisor for the Student Chapter of the American Society for Engineering Education at UPRM. Santiago’s research interests include investigating students’ understanding of difficult concepts in engineering sciences, especially for underrepresented populations (Hispanic students). She studied the effectiveness of engineering concept inventories (Statics Concept Inventory - CATS and the Thermal and Transport Concept Inventory - TTCI) for diagnostic assessment and cultural differences among bilingual students. She has also contributed to the training and development of faculty in developing and evaluating various engineering curriculum and courses at UPRM, applying the outcome-based educational framework. She has also incorporated the Content, Assessment, Pedagogy (CAP) model to the development and redesign of courses, laboratories, and educational experiences implemented successfully in the course offerings at UPRM. Another research area includes the incorporation of Responsible well-being in faculty and students (undergraduate and graduate). Through an innovative research-based assessment plan, they determined the levels of moral development achieved by participants. In the past two years, Santiago has incorporated theories on social cognitive career choices and student attrition mitigation to investigate the

effectiveness of institutional interventions in increasing the retention and academic success of talented engineering students from economically disadvantaged families. Finally, the latest project explores the relationship between the institutional policies at UPRM and faculty and graduate students' motivation to create good relationships between advisors and advisees.


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**Keywords**: Intervention model, College success, Low-income students

## Abstract

This paper assesses the effectiveness of an intervention model aimed at propelling low-income, academically talented (LIAT) engineering students in a Hispanic Serving Institution (HIS) into actions, immersing them into real-life contexts. The model, named the LIAT College Access and Success model (L-CAS), integrates elements from Lent's Social Cognitive Career Theory and Tinto's Departure model in a framework provided by a structured scholarship program designed to mitigate the economic hardship of students while also providing a multistage intervention plan to improve their success metrics. In this paper, we revisit the theoretical foundations of the L-CAS model and the academic setting where it was implemented to look at the data acquired throughout its application during three years on a pilot group of 92 students. We assess the model effectiveness for springing LIATS into actions leading to their success while reflecting on the results obtained so far. We also discuss opportunities for improvements and the projections for a scaled porting of the model to a campus-wide level.

## I. Introduction

Educational research has widely documented the achievement gap between students from different socioeconomic statuses (SES). The seminal work by Coleman et al. in 1966 sparked a myriad of studies and initiatives addressing this phenomenon with different views regarding relation, incident factors, or effects [1][2][3][4]. Despite more than fifty years of documented efforts, the prevalence of the gap, studied at national and global levels, continues to highlight the need for renovated approaches [5][6]. At the college level, this gap manifests among students from lower SES with a higher attrition level, longer times to graduate, and significantly lower retention and persistence indexes than those observed among students with higher status [7], [8].

For the last three 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 been implementing strategies to address the SES gap among engineering students [9]. The UPRM is a Hispanic Serving Institution where over 70% of students come from families with low SES [13]. For engineering students in this group, the gap has manifested with up to 20% higher attrition and 18% longer time to graduation than those of their peers with higher SES.

PEARLS introduces a series of interventions organized around a theoretical model named the LIAT College Access and Success model (L-CAS). The L-CAS application was enabled through a set of longitudinal activities with objectives ranging from boosting engineering LIATS self-efficacy beliefs to propelling them into actions immersing them into real-life contexts. Context scenarios targeted the development of collaborations and interactions in communities of practice that would lead them to develop practical skills for growing as competitive researchers or practitioners in the workplace.

The main question driving this part of our research was how the application of the L-CAS model impacted engineering LIATS in an HSI in their actions as third- and four-year students, leading to the successful completion of their studies and professional preparation.

After three years of longitudinal application of the L-CAS model on a pilot group of ninety-two engineering LIATS, this paper assesses the model's effectiveness in reaching the said objectives. The rest of this document is organized as follows. Section II revisits the theoretical foundation of the L-CAS model to briefly review its stages and interventions and describe the academic setting where the model was applied and the framing program. Section III offers details of the way the L-CAS model was implemented, highlighting the plot of curricular, co-curricular, mentoring, and leadership activities that formed the program interventions. Section IV provides a look into the results obtained throughout the three years of activities to assess the model impact and effectiveness in springing LIATS into actions. Section VI provides our reflections on this journey, highlighting the keys for success in the L-CAS model application and our views of how the model can be ported and scaled up to a campus-wide level. The last section provides concluding remarks on this experience.

## II. L-CAS Foundation, Setting, and Participants

The theoretical foundation of the L-CAS model was initially introduced by Jimenez et Al. as part of the core components of PEARLS [9]. This section briefly revisits the model, devoting most attention to the implementation of its late stages.

### *A. Model Foundation*

The L-CAS model was designed to integrate elements from Lent's Social Cognitive Career Theory (SCCT) [10] and Tinto's Departure model [11] in a hybrid structure aimed at boosting success metrics among LIATS. The hybrid nature of the model arises from the deliberate aim in the design of combining proven socio-cognitive career theories with institutional factors to steer students into actions. The career choices made by our subjects, their development, and adjustment in an educational setting were expected to be shaped by factors that included self-efficacy beliefs, expected outcomes, and individual goals. PEARLS worked with interventions aimed at shaping these factors to achieve success. Early program results shed light on the model effect on first-year retention and persistence in second and third-year students [9]. These indicators scored high in our subjects, creating a positive expectation of the outcomes in later stages. However, the effect of the shaping process in the formative and growth levels could only be assessed in later years of the student's development; through their performance and the concrete actions taken by them to define their profiles as future professionals. Figure 1 reproduces, for convenience, the conceptual structure of the L-CAS model.

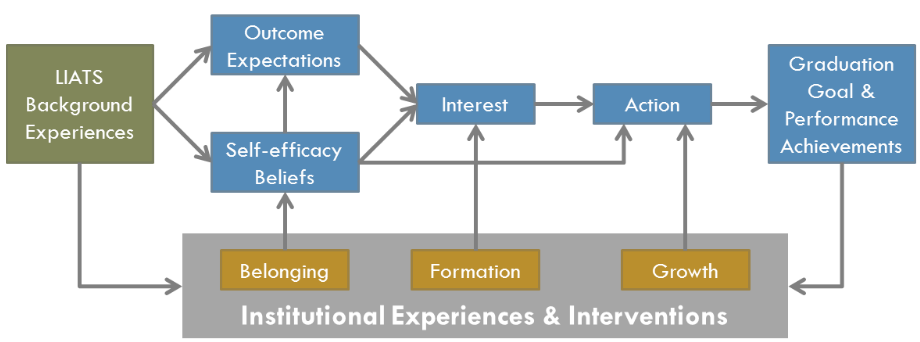


Figure 1: LIAT college access and success model [9].

### *B. Academic Setting*

The UPRM is a Hispanic Serving Institution (HSI) with an academic offering grouped in four colleges: Agriculture, Arts & Sciences, Business Administration, and Engineering. Being part of the University of Puerto Rico (UPR) system, the Mayaguez campus is recognized for its engineering school. The 2020 American Society of Engineering Education annual survey positions the UPRM as one of the top five schools in the nation producing Hispanic Engineers, serving a population of 12,703 students composed in its totality by underrepresented minorities [12]. In 2020, 41.5% of its student body were engineering students, in its vast majority undergraduates (97.8%), enrolled in nine bachelor's level degree programs. Records held by the Office of Economic Aid indicate that nearly 70% of students qualify for Pell grants.

### *C. Participants' Profile*

A total of 92 students were initially selected for participating as subjects in the project from an initial pool of nearly 2,400 applicants. The selection process included online application, info-sessions, screening, and interviewing to land on the final group of participants. The group was composed of 89 undergrads and two master's level students. In this group, 39 undergrads and the two grads received scholarships (scholars) and the rest were accepted as participants with no economic aid. The average household family income among scholars was $14,512/year; and $44,216/year among participants. The gender distribution had a 43% to 57% ratio of females to males, with 37% first-year students, 31% second-year, 30% third-year, and 2% grads. The distribution by study program had 15% each in chemical, computer, and mechanical engineering. Electrical, industrial and software engineering had 14%, 13%, and 10%, respectively; while civil engineering, surveying & topography, and computer science had 7.6%, 5.4%, and 2.2% respectively. As the program unfolded, student transfers within engineering and to external programs, attrition, and graduations reshaped the map, resulting at the end of the third year in 81 students distributed as illustrated in Figure 2.

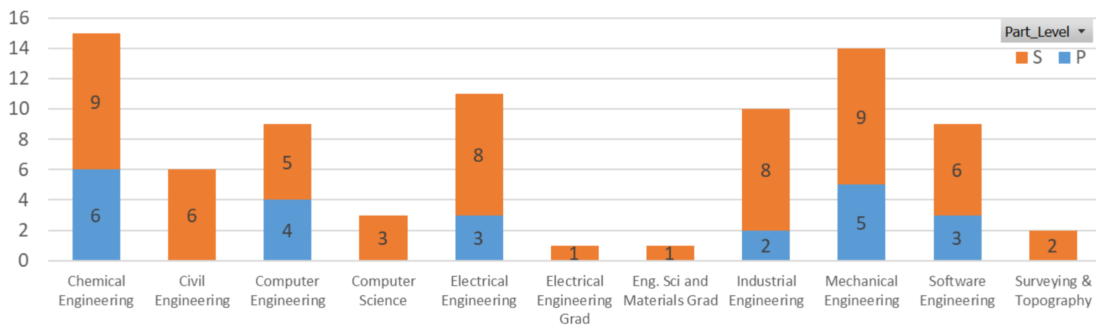


Figure 2: Distribution of students per study program at the end of the 3rd year.

The remaining 11 students (12%) correspond to those who left the program for diverse reasons: 2 transferred outside engineering, 3 left the university, 3 graduated, 2 dropped their academic performance and stopped participating, and one lost economic eligibility (refused to continue as a participant).

## III. Implementing the L-CAS Model

The core of PEARLS is provided by the L-CAS model implementation and its framing onto the scholarship program. Complementary components include a peer-mentor program that provides students with leadership opportunities and a faculty mentoring program that complements the academic counseling provided in each academic program. Career planning is aided by an Individual Development Plan (IDP) that allows each student to establish a plan for the different stages of their development in their pathway to professional life [15]. IDPs are used by both, undergrad and graduate students in the program.

The implementation process for the L-CAS model used institutional interventions delivered through formative activities in a longitudinal plot that evolved as students progressed in their pathway to complete their engineering degrees. Activities developed for each stage are briefly described below.

### *A. Belonging Stage Activities*

The belonging stage of the model used a sequence of two one-credit free electives designed as part of the program. The courses included:

- INGE-3001 – Introduction to Engineering was used for exposing first-year students to all engineering disciplines offered in the College of Engineering.
- INGE-3002 – Introduction to Learning Communities: developed a non-conventional learning community connecting first-year students with seniors completing their capstone design project [17].

The combination of these two courses allowed for students to reassure (or change) their selected study programs early in their development pathway, reducing the chances of program transfers later in their study program, when such a change could imply credit loss and delays in their progress towards graduation. Talks and workshops offered at this stage as co-curricular activities complemented the courses by reinforcing the sense of belonging of and fomented students' outcome expectations for the post-graduation stage. Table 1 lists the topics offered during the first three years of the program, containing those for the belonging stage in the first column. The thematic in the first two terms included informative talks and early career planning. This first year also witnessed the completion of the first version of students' IDPs.

### *B. Formative Stage Activities*

Formative and growth interventions during years two and three were delivered through three main activities: formal courses, informal talks and workshops, and action opportunities. Each term also included a social activity to reinforce the development of ties among program students, faculty, and staff.

The courses in the PEARLS curriculum for these stages included:

- INGE-3003 – Undergraduate Seminar: a variable credit elective course of 1 to 3 credits designed to develop students' soft skills using the affinity research group (ARG) model [18].
- INTD-3355 – Information Literacy: a three-credit elective aimed at developing students' introductory research skills, emphasizing search, retrieval, classification, literature selection, and research integrity.

Talks and workshops in years two and three continued to provide additional formation to students. For the second year, talks focused on the subjects of financial savviness and undergraduate research advantages, while those in year three addressed professional projection, integrity, and post-graduation choices. Table 1 lists, in its middle and right columns, the series of activities offered to students in this category.

The bottom half of PEARLS' second year coincided with the onset of the Covid-19 pandemic, which forced activities to migrate to a virtual format, as denoted in Table 1. This format change did not hinder the offering of activities. Part of year two activities and all offerings in year three were redesigned for synchronous online offer and students seamlessly moved to online participation. Recordings of activities were made available through the program website [19].

Table 1: Scheduled talks & workshops as co-curricular activities.

| Year 2018 - 2019 | Year 2019-2020 | Year 2020-2021 |
|---|---|---|
| **Fall 2018** | **Fall 2019** | **Fall 2020** |
| Pearls Info Session | How to Manage a Budget | Resume writing, e-portfolio & LinkedIn Page Development for Engineering Students* |
| Scholarship Awards Ceremony | National Fellowship Workshop | PEARLS Scholarships: Seeds for Transforming Lives* |
| First Meeting: Work Plan and Rules | Undergraduate Research Experiences: A Report | Mentors and Mentees, Resume, e-portfolios, LinkedIn* |
| | From Business Idea to Business Plan | A New Perspective on Leadership* |
| | Thanksgiving Pearls Dinner (Social) | Building Resilience for a Better Life* |
| | | Tools for Handling Stressful and Difficult Situations* |
| | | Semester Closing & Student Recognitions (Social)* |
| **Spring 2019** | **Spring 2020** | **Spring 2021** |
| Creating Your Career Path | Anxiety Management in the Midst of Adversity | Academic Honesty in Times of Crisis - Panel* |
| Introduction to Research | The Business Model Canvas | Responsible and Appropriate Conduct of Research* |
| Creating an ePortfolio | Undergraduate Research: A Necessity in Cross-Disciplinary Engineering Education* | Ethics in the Engineering Profession* |
| Plagiarism and Academic Honesty | Social activity canceled due to Covid-19 pandemic | How to Write Compelling Research & Personal Statements for Grad School Applications* |
| Semester Closing & student recognitions (Social) | | Benefits & tools to carry out undergraduate research: Mentoring, research networks, & professional development plan* |
| | | Data Presentation: Dos and Don'ts of Figures, Plots, & Images* |
| | | PEARLS Semester Closing Activity (Social)* |

* Denotes activities carried in synchronous online format

### *C. Growth Stage Activities*

Growth opportunities for student actions included industry experiences, undergraduate and graduate research, special projects, and leadership experiences.

- Industry Experiences: These experiences, enabled through cooperative education courses offered by each academic program in the CoE (XXXX-4995), allow students to gain job experience while earning college credit. PEARLS encourages participants to have one COOP experience during regular terms and to consider summer COOP or internship opportunities as they arise. Although the latter doesn't count for credit hours, it provides the opportunity to acquire work experience in industry.
- Undergraduate Research (UR): Most academic programs offer up to six credits in undergraduate research (XXXX-4998). PEARLS encouraged students to acquire such experiences for their growth as future professionals. UR courses provide a gateway to engage with on-campus research opportunities. Students also had the option of applying and participating in Research Experiences for Undergraduates (REU) programs elsewhere. PEARLS provided talks about this option and maintained an updated link in its web page to hundreds of offers nationwide each year.
- Special Projects: Participation in national project competitions is enabled through special projects. These activities, offered for credit in several CoE academic programs, provide

students with the opportunity of becoming part of faculty-supervised, large teams of students working to participate in national competitions.

- Leadership Opportunities: The CoE hosts over fifty student-led organizations with plenty of opportunities for students to develop and flourish in leadership skills. PEARLS students are encouraged to take part in such opportunities. Another venue for exercising leadership is through the PEARLS peer-mentor program (PMP). This program allows students to become mentors of their peers, complementing the job of faculty mentors. Student mentors are required to complete a training on peer mentoring before delving into such endeavors.

The PEARLS faculty mentor program resulted like a tying bow for all L-CAS stages. Interactions with faculty mentors provided students, since their very first year of study, with a worry-free mechanism to access faculty without the pressure of being evaluated for grades. This allowed program mentors to gain the trust of students and provide them with counseling for decisions such as course-taking, opportunities selection, IDP development, and conflict dealing among a long list of benefits. PEARLS provided one faculty mentor for each academic program, except the pairs Civil Engineering and Surveying & Topography, and Computer Science and Software Engineering, which, because of their affinity and number of students, shared one faculty mentor each. Graduate students had a separate faculty mentor for all disciplines. PEARLS provided its faculty mentors with training on mentoring strategies and ways of dealing with stressful situations, as well as with referral mechanisms for professional counseling and other student services offered by the university.

## IV. Results from Applying the L-CAS Model

A look into the data acquired throughout the years via surveys and direct interactions with students allowed assessing the model effectiveness for springing them into actions. The observed results reveal a great interest and participation of students in all three target areas, and how they became a group of outstanding scholars in their path to graduation.

### *A. Belonging Stage (Year 1)*

Since the first year of PEARLS, students have enthusiastically participated and supported all program activities and showed excellent academic performance. Activities during year one focused on developing in students a sense of belonging to their programs and developing awareness and understanding of what comprises the discipline of engineering. Some of the salient observations of this group at the end of year one are listed below.

*Student Persistence, Retention, and Academic Performance*: Persistence and retention during the first year ranged from 97 to 100%. Only one participant left the university for personal circumstances, but all other students enrolled for the next academic year. All graduate students (100%, n=2) completed all enrolled courses, exhibited satisfactory progress in their research, and re-enrolled in the new academic year.

Table 2 lists the distribution of the undergraduate students in each initial cohort, the percentage of students who proceeded to enroll for their next year, and the 10-year persistence average reported by the CoE for corresponding academic years.

In terms of participants' academic performance, 85.9% of PEARLS students (79 out of 92) completed the 2018-19 academic year with GPA above 3.0/4.00. Moreover, 58.2% of them (42 out of 79) had a GPA of 3.50/4.00 or above. The engineering college-wide average GPA for the same year was 2.66/4.00. Only 12.2% of PEARLS students (11 out 92) obtained a GPA between

2.66 and 2.99. All in all, 97.9 % of PEARLS students performed above the reported college average GPA.

Table 2. Retention - Belonging Stage (Year 1)

| Cohort 2018-19 | Withdrew from UPRM | PEARLS enrollment in academic year 2019-20 | UPRM 10-yr. persistence average - CoE |
|---|---|---|---|
| First-year (n=34) | -1 | 97.1% (n=33) | 91.9% |
| Second-year (n=28) | 0 | 100% (n=28) | 84.4% |
| Third-year (n=28) | 0 | 100% (n=28) | 77.9% |

*Curricular and Co-curricular Activities*: During the first year, a total of seven sections of four different courses were offered, registering a total enrollment of 184 students, from which 41.84% (n=77) were program students (PS). Having more than 50% NPS benefitting from the course offer highlights the L-CAS impact on students beyond the program. Table 3 lists the enrollment registered in all by PS and NPS in the three years of the program.

Table 3: Enrollment in program courses.

| Course Code | Year 1 | | Year 2 | | Year 3 | |
|---|---|---|---|---|---|---|
| | NPS | PS | NPS | PS | NPS | PS |
| INGE-3001 | 62 | 28 | 13 | 1 | 47 | |
| INGE-3002 | 3 | 20 | 10 | 12 | - | - |
| INGE-3003 | 0 | 23 | | 37 | 6 | 8 |
| INTD-3355 | 42 | 6 | 10 | 4 | 16 | 16 |
| Totals | 107 | 77 | 33 | 54 | 69 | 24 |

During the first year, PEARLS offered a total of eight co-curricular activities: four were general meetings and the rest corresponded to talks and workshops. Student participation in these activities in general, remained relatively constant throughout the entire academic year, with a rate of over 70% in almost all of them. Table 4 lists the attendance registered in co-curricular activities in the three years of the program.

Table 4: Attendance to co-curricular talks and workshops.

| Activity Sequence | Year 1 | | Year 2 | | Year 3 | |
|---|---|---|---|---|---|---|
| | Fall | Spring | Fall | Spring | Fall | Spring |
| Talk/Workshop 1 | 628* | 78 | 56 | 40 | 51 | 50 |
| Talk/Workshop 2 | 78 | 66 | NR | 32 | 48 | 31 |
| Talk/Workshop 3 | 79 | 71 | NR | NR | 49 | 35 |
| Talk/Workshop 4 | | 71 | 51 | - | 47 | NR |
| Talk/Workshop 5 | | 56 | 45 | | 49 | NR |
| Talk/Workshop 6 | | | | | 46 | NR |
| Talk/Workshop 7 | | | | | 65 | 38 |

### B. *Formation Stage (Year 2)*

Year two focused on shaping students' career paths and providing options to succeed in that journey. Salient observations made during year two are summarized below.

*Persistence, Performance, and Progress Towards Graduation*: Engineering programs in the host institution are five-year-long. Table 5 lists PEARLS students' persistence from year two to year three and compares them to the general CoE population. Values ranged from 96.4% to 100%.

Table 5. Retention - Formation Stage (Year 2)

| Cohort | 2019-20 Academic Year | Withdrew from UPRM | PEARLS enrollment in the academic year 2020-21 | UPRM 10 yr. persistence average - CoE |
|---|---|---|---|---|
| First-year | Second-year (n=33) | -1 | 96.4% (n=32) | 84.4% |
| Second-year | Third-year (n=28) | 0 | 100% (n=28) | 77.9% |
| Third-year | Fourth-year (n=28) | -1 | 96.4% (n=27) | 75.0% |

Towards the end of the PEARLS' second year, three students had left the university. The overall program retention rates exceeded the averages reported by the CoE. Although not all students continued in the program, 95.6% of the students from the initial cohorts remained in engineering programs. One student transferred to another program outside engineering.

The group of graduate students witnessed the graduation of its first scholar in year two: a student in the Civil Engineering Master's program completed her degree and joined the labor market. The second graduate scholar, although enrolling for continuing in her study program, lost economic eligibility and left PEARLS. Two new graduate recruits were welcomed into the program the next term.

At the end of the second year, 97.6% of all scholarship recipients in the program (all levels) continued to enroll for their next study year, persisting in their study programs. Among participants, school persistence was 96.0%. Overall, 96.7% of PEARLS students persisted. In terms of academic performance, 85.22% of PEARLS students (75 out of 88) completed their second year in the program with GPA above 3.0/4.00. Moreover, 54.7% of them (41 out of 75) held a GPA of 3.50/4.00 or above. During the previous year, the engineering college-wide average GPA was 2.66/4.00. A small proportion, 13.6% of PEARLS students (n=12 of 88), maintained GPAs between 2.10 and 2.99. Overall, 96.5 % of PEARLS students performed above the last published CoE average GPA.

At the end of year two, 87.5% of PEARLS students (n=77 of 88) had approved 75% or more of their graduation credits for their study level. Moreover, 33% of program students had approved 100% or more of their graduation credits for their study level. No significant differences were observed between participants and scholars.

*Curricular and Co-curricular Activities*: The curricular offer during year two was similar to that of year one, with a total seven of sections of the four program courses. Table 3 lists the enrollment registered in the second year. Once again all courses were open to the entire engineering population, resulting in 38% (n=33) NPS. This time the balance of PS vs. NPS denoted high participation by program students (62%, n=54), particularly in the Undergraduate Seminar, a key course for steering student actions. Nevertheless, the observed participation in these courses denoted they impacted a large proportion of program students and beyond.

Co-curricular activities were somewhat skewed by the onset of the Covid-19 pandemic, as not all planned activities could be offered and some were not properly registered. Table 4 lists the participation of students in fully registered activities during year two. Despite the glitches, participation was observed high (57.6%) and our recollection of those non fully registered activities had similar rates of attendance by program students.

*C. Growth Stage (Year 3)*

This important L-CAS stage is where students were expected to spring into actions with a strong impact on their future as engineering professionals. Those inclined to continue a path to join the STEM labor market were expected to bring-in industry experiences, while those attracted to research and graduate studies were expected to steer into research experiences; all without deviating from reaching the graduation goal. Year three witnessed a mixture of formation and growth interventions, as our three major groups were in different stages of progress in their study programs. The most important observations of the third year are listed below.

*Persistence, Performance, and Progress Towards Graduation*: By the end of the third year, 88% of PEARLS fifth-year students (n=22 out of 25) continued into their sixth year of study. Three students (12%) graduated in five years or less, denoting an on-time graduation rate that doubles that of the general engineering population. These numbers, although encouraging, are considered early for our program as most fifth and six-year students are still taking courses and PEARLS still has two more years left. Our assessment of third-year performance revealed that 64% of fifth and six-year students had completed at least 82% of their coursework. Moreover, 96% (n=24 out of 25) are expected to graduate in 6.5 years or less. As a reference, over two-thirds of engineering students at UPRM graduate in 7.5 years or more. Persistence in year three scored high, as in previous years, with 100% among sixth-year students (n=27), 96.0% among fifth-year (n=24 of 25), and 96.3% among third-year students (n=26 of 27).

Academic performance indicators also remained high. 91.4% of program students (n=74 of 81) completed the 2020-21 academic year with GPA above 3.0/4.00. Moreover, 53.1% of them (n=43 of 81) held a GPA of 3.50/4.00 or above. Overall, PEARLS students' average GPA was 3.51/4.00, with only 4.9% maintaining GPAs between 2.67 and 2.97. The latest average for the CoE at the time of this writing was not available yet. This year, the rate of academic performance across SES (participants/scholars) was observed to be 86% to 78% based on student standing. This has been the wider gap observed so far in the program, less than half than that observed in the general CoE population (19%). Persistence and progress towards graduation indicators maintained smaller gaps. All graduating students in the program so far are scholars.

*Curricular and Co-curricular Activities*: The curricular offer in year three shrunk to only three courses with an equal number of sections. INGE-3002 was not offered as establishing a virtual engineering learning community for course activities was not possible with the pandemic limitations. NPS enrollment bounced back to 74.1% (n=69 of 93). The highest PE group was registered in INTD-3355. Table 3 lists the enrollment levels reached in each course.

Opposite to the course offer, co-curricular activities exhibited significant growth in year three, despite the pandemic. A total of 14 activities were offered, nearly doubling those offered in the previous year. This increase, in part, attempted to compensate for the reduced course offer and the fact that face-to-face interactions were out of consideration. Student participation this year was somewhat lower than in previous years. Surveys carried with each offer, denote that although students still gave high scores to the quality of the activities, the weight of online courses and the frequency of activities took a toll on participation.

*D. Record of Student Engagements*

The record of student engagements during the three years of the program tracked the number of instances students participated in growth opportunities as listed in Section III. Moreover, we also included recognitions and technical presentations as engagements since they required actions by the students. Figure 3 plots the number of student engagements registered throughout the program. It shows students have been taking positive actions since the first year. This is no surprise as our study group was composed of three different cohorts. However, it can be observed how the number of engagements grew as students matured.

## V. Reflections on the Experience and Model Projections

After three years in the journey of deploying the L-CAS model as part of PEARLS, several reflections come to our minds. Below we reflect on the observed results on students, on some of the lessons learned, and think about challenges for scaling up L-CAS to a college- or campus-wide level.

### *A. Reflections on Student Performance*

After three years applying the L-CAS model on our pilot group, results are very encouraging. Students were retained and have persisted in their study programs at rates higher than peers in the general CoE population. Progress in their respective study programs have been steady and at a rate that outpaces students in the general population. They have begun to show graduation rates that double that of the rest of the engineering students. Moreover, students have accumulated an outstanding number of high profile engagements in industry and research experiences, in leadership, and recognition, among other actions that convert them into highly competitive engineering prospects.

An important observation is that all these success indicators behaved similarly for participants and scholars, denoting significantly narrower socioeconomic status gap between them. All these indicators create a basis to argue that the L-CAS model indeed has an effect on the level of success of LIATS and contributes to narrowing the SES gap.

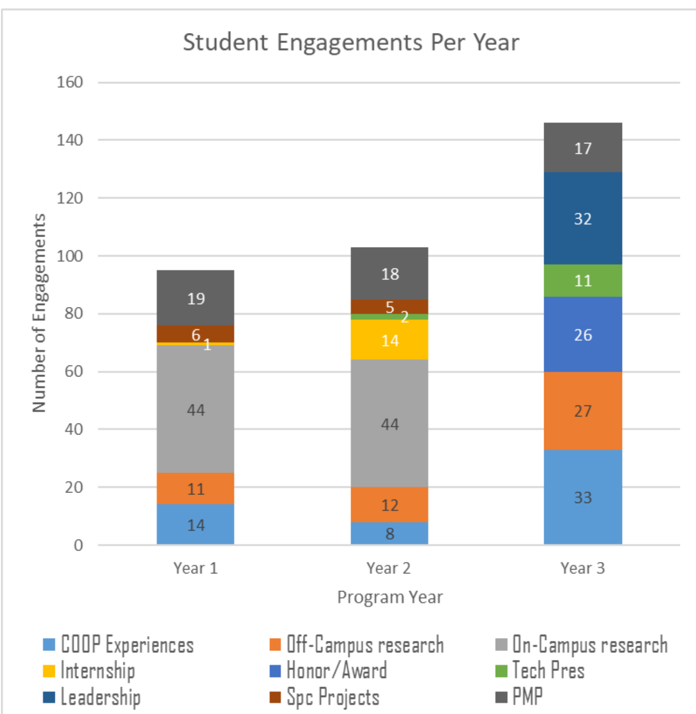


Figure 3: Record of student engagements in actions shaping their future during the program years.

### *B. Lessons Learned*

The experience has not occurred without areas offering room for improvements. The graduate component of the program did not unfold as expected. During all three years only half the planned capacity of graduate scholarships has been occupied. This outcome, we found, was in part due to the way scholarships were distributed. The amount of graduate scholarships fell below that of graduate assistantships, and although the program rules allowed for combining economic aid sources, the arrangement did not result attractive for most students. Despite this unexpected result, those grads who joined the program did benefit from the L-CAS model, as denoted through the collected data.

### *C. Considerations for a Scaled L-CAS Deployment*

Replicating the results reported for this pilot program at a wider scale such as college- or campus-levels presents several challenges. One of the keys for the program success, according to students' opinions, is the faculty mentoring component. Mentoring in PEARLS goes beyond the work made by faculty during office hours, requiring accommodating this activity as part of their academic load. This consideration becomes an important factor to deal with if L-CAS were to be scaled-up. Also, identifying sources of funding for a larger pool of LIATS has inherent challenges. A third important challenge is the offering of courses and workshops for large groups in a sustainable way. Considerations for academic schedule, faculty allocation, and insertion in academic programs would need to be carefully considered. These are not insurmountable challenges, but successful scaling of the model application would require devising ways of appropriately dealing with them.

## VI. Conclusion

We have presented the implementation of an intervention model, the L-CAS, for impacting and improving success metrics among socioeconomically disadvantaged engineering students in a Hispanic Serving Institution. Results of the first three years of application support the hypothesis that the designed interventions played a role in the observed performance improvements of a small pilot group. Moreover, the SES gap perceived among the general population in the targeted school is significantly reduced within the study group. The analysis also identifies areas that can be improved in the program as well as challenges to be dealt with for a scaled model implementation.

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