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Lessons Learned From the First-Year Enrichment Program for Engineering and Computer Science Students in the ASSURE-US Program

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Lessons Learned from the First-year Enrichment Program for Engineering and Computer Science Students in the ASSURE-US Program at California State University, Fullerton

Abstract: ASSURE-US program, started in 2018 through NSF funding, targets first- and second-year engineering and computer science students, especially those underrepresented ones, enrolled at California State University, Fullerton (CSUF) to foster socio-cultural interaction, demonstration-based learning experiences, and curriculum-related research experiences of students. Our activities have impacted nearly 400 out of approximately 4700 students enrolled in engineering and computer science programs at CSUF as of Fall 2020, with many of them as first-year freshman students. In this paper, we present preliminary findings of two first-year enrichment programs in ASSURE-US: the student teacher interaction council (STIC) and the student summer research, as well as lessons learned from two years' implementation of the project in order to improve the project implementations for future years.

1. Introduction

Billions of dollars are allocated every year to fund research, program development, and direct services aimed at increasing the number of women, minorities, and underrepresented populations entering the STEM major/career pipeline. Nevertheless, disparities in STEM representation of the Hispanic community prevail. Hispanics account for 17.4% of the US population, and nearly 20% of the youth population (21 years and below) is Hispanic, yet they account for just 7% of the US STEM workforce. Ensuring America's global competitive edge in science and technology is contingent upon a steady supply of skilled workers in STEM disciplines. According to President's Council of Advisors on Science and Technology (PCAST, 2012), growing Hispanic student population has a unique advantage to fill this critical gap in STEM workforce by increasing their retention in STEM disciplines.

However, narrowing the achievement gap requires careful consideration of underlying causes that affect Under-Represented Minority (URM) students', such as Hispanic and African American's unequal participation in STEM disciplines. For students, often a combination of ethnicity, gender, sociocultural influences, academic experiences and preparation, cognitive, attitude/perceptions, institutional variables, and environmental factors affect not only their choice of majors, but also their ability to perform and succeed in the chosen major (Coulombe and Gil, 2016; Crisp and Nora, 2012).

In general, retention of students in STEM disciplines is very challenging, particularly for the low-income, first-generation minority youth, the majority of whom lack foundational skills and knowledge in the STEM fields (NCES, 2011). Besides the rigors of STEM disciplines, sociocultural and socio-psychological factors act in tandem to create barriers to their success, leading to poor retention, lower graduation rates, and eventually the perpetuation of the achievement gap between URM and non-URM students. In fact, the economic disadvantage of URM students is not unique to any particular Hispanic Serving Institution (HSI) such as California State University, Fullerton (CSUF). The National Center for Education Statistics (NCES) reported that during the 2011-2012 academic year, 70% of the Hispanic students had an unmet financial need. Economic disparity, family obligations, cultural conditioning and prior

academic preparation creates an uneven competition between the URM and non-URM students, thereby perpetuating the achievement gap. This implies that underrepresentation of minority and female population in STEM is a systemic problem that requires not only academic interventions but also socio-cultural interventions.

Various studies showed positive gains such as retention and an overall increase in the graduation rate of URM students through decisive social intervention (Carpi et al., 2013, ACT, 2015; Clark et al., 2012; Tsui, 2007; Palmer and Gasman, 2008). These studies attributed the differences due to cognitive (aptitude, comprehension, reasoning, knowledge acquisition, and abstract thought), socioeconomic (poor vs. affluent), structural (family, neighborhood, school, and cultural influences), and social-psychological factors (motivation, expectations, persistence, conscientiousness, and self-control). According to the studies, social support mechanisms provide students with opportunities to strengthen their skills, identify with role models, and establish a sense of belonging within the engineering discipline. Such acceptance is one of the most critical aspects of minority student retention (Matthews, 2017).

Furthermore, multiple studies shows that the informal communication and accessibility of faculty role models to provide moral, educational, and cultural support to students would ultimately result in students maintaining their enthusiasm, confidence, and retention in STEM disciplines (Lisagor et al., 2013; Concepción et al., 2009). These studies reported that by building rapport, both the students and the faculty were equally benefited. The participating faculties in these studies gained an understanding of URM students' pressing issues, such as immigration, financial, and family obligation which helped them make changes in their approach to teaching, mentoring, and advising. On the other hand, the URM students developed an increased sense of belonging to the university, greater awareness of student support services including avenues for student questions, and concerns being addressed (Lisagor et al., 2013). In one of the most comprehensive studies involving 10,071 Latino/a students (Lundber et al., 2018), the authors reported that high-quality interaction with faculty resulted in enhanced learning with students working hard in response to the faculty's availability and expectations.

ASSURE-US program, started in 2018 through NSF funding, targets first- and second-year engineering and computer science students, especially underrepresented ones, enrolled at California State University, Fullerton (CSUF) to foster socio-cultural interaction, demonstration-based learning experiences, and curriculum-related research experiences of our students. Specific objectives include 1) creating a nurturing learning environment through the formation of the Student Teacher Interaction Council (STIC); 2) providing culturally meaningful learning experiences involving extensive laboratory and field experiments; 3) providing first-year research experiences to freshman engineering students to generate and sustain interest in STEM; 4) integrating research activities into curriculum to increase real-world relevance of research experiences; 5) and improving the analytical instrumentation and critical thinking skills of undergraduate students that could prepare them for graduate studies.

ASSURE-US students additionally received a variety of support from the project, including peer mentoring, advice and counsel from ASSURE-US faculty during STIC meetings, summer research experiences, and scholarship and textbook support. Peer Mentors, under direct supervision of the ASSURE-US Principal Investigators and Senior Personnel, support

undergraduate students in the ASSURE-US program with general mentoring and referrals and engage in ECS undergraduate student community-building activities for 5-10 hours per week.

In this paper we present findings of the two major first-year enrichment activities in the ASSURE-US project: 1) *Student-Teacher Interaction Council (STIC),* and 2) *First-Year Undergraduate Research Experiences* completed in Academic Year 2018-2019 and Academic Year 2019-2020, as well as lessons learned from these two activities to improve their implementation in future years.

2. First-year Enrichment Activities in ASSURE-US

a) *Student-Teacher Interaction Council – STIC Together*

Consistent with literature, the formation of the Student-Teacher Interaction Council (STIC) is to build rapport with students, facilitate informal communication between students and faculty, present role models to emulate and seek inspiration from, educate students about campus resources and opportunities available for success, and keep motivation and enthusiasm levels high so that they remain engaged in their academic pursuits. Towards that end, the following activities were planned and implemented: a) informal social gathering for students to interact with faculty members; b) workshop for on-campus resources to improve student success; c) workshop for time management, stress relief, and exam preparations; d) financial planning (student scholarship, assistantship, grants and loans) and on-campus employment workshop; and e) forum for culturally diverse faculty, industry professionals to share their experiences. The anticipated outcome of STIC activities is better student rapport, increase in student persistence and perseverance, increased motivation to pursue STEM learning, increased awareness of resources, and enhanced situation handling and coping skills.

The informal gathering took place in fun places in campus, the bowling arena and pooltable zone, where food, drinks, and opportunity drawings were gifted to the students. The workshops for on-campus resources, time management and financial planning took place in different months, at least one month appart, at different hours of the day, in the same large classroom with round tables, and consisted of oral presentations, roundtable discussions, printed brochures offered to the students, food, drinks and opprtunity drawings. The forum with faculty and industry professionals took place in a medium sized classroom and consists of a panel discussion followed by Q&A.

b) *Undergraduate Research Experiences*

To increase the persistence of URM students in STEM disciplines, undergraduate research consisting of laboratory/field activities and design projects that involve students, peer mentors and faculty members were implemented in ASSURE-US. The objective of first-year research experience and Summer Undergraduate Research Experiences (SURE) is to increase students' comprehension of concepts and topics and develop skills through real-world experiences.

During the academic year 2018-2019, the first-year Summer Undergraduate Research Experience (SURE) in ASSURE-US hosted five faculty members mentoring 21 first and second-

year undergraduate ECS students. The five faculty members provided eight cutting-edge research projects for students to select within their interest. Students received a stipend to assist ASSURE-US leadership team members in conducting research projects that included:

- Real-Time Object Detection using Artificial Intelligence
- Self-driving Lego Robot using Artificial Intelligence
- Hardware Accelerated Deep Neural Networks
- High-Performance Computing using Non-Volatile Memory (NVM)
- Study of Radio Frequency Energy Harvesting for IoT Devices
- Design, Fabrication, and Analysis of Low-Cost Solar Powered Energy Harvesting Micro Air Vehicles using 3D Printing
- Design, Fabrication, and Analysis of Low-Cost Customized Electric Skateboards
- Data science projects using Jupyter Notebook

The SURE took place in the labs associated with each discipline. The students were informed by an email about the list of faculty and their research topics, and they were given the opportunity to contact the individual faculty to be considered for SURE. In Summer 2019, all students who have contacted the faculty were accepted and they had to undergo a hiring process through the university to become research assistants. The selected students were given access to desktops, a black-and-white printer, books on the topic, and necessary materials to create their posters. The peer mentors were available for about 4 hours a day to answer students' questions or provide technical support. The faculty met with the students daily for 1-2 hours to present research topics, give feedback on the ongoing research activities and provide materials to support students' learning. The peer mentors were hired at the beginning of each academic year. They were selected among the students who took courses with the faculty, have performed well in these courses, had great communication skills, and/or were part of ASSURE-US cohort the year before. The students were given the option to choose a real-world problem to work on, to work individually or in groups, and to present their findings as a video or a poster in the last day, June 28. Faculty outside the SURE were invited to watch the videos and see the posters. But because the event took place in summer, only the chairs of departments have attended.

c) Data Collection and Research

Arroyo Research Services (ARS) conducted the ASSURE-US external evaluation and collaborated on the ASSURE-US research study. The external evaluation was intended to complement and support both the programmatic and research aspects of ASSURE-US.

The ASSURE-US research and evaluation instruments were built from psychometrically sound instruments and scales. For instance, the Career Interest Questionnaire and Modified STEM Semantics Survey (Tyler-Wood et al., 2010) and the Student Attitudes toward Science Survey (Gibson and Chase, 2002) were used to measure student fascination, value and competency beliefs with STEM education and careers.

For the first-year engagement activities in ASSURE-US, data were collected to study the following three research questions, 1) Do informal faculty interactions have a positive impact on URM student persistence in STEM education at HSI? , 2) Does first-year student involvement in faculty-directed, field-based research experience have a positive effect on retaining

undergraduate students pursuing STEM majors? and 3) How did COVID-19 affect the research experience of undergraduate students pursuing STEM majors?

3. Preliminary Findings

a) *Student participants*

Our activities have impacted nearly 400 out of approximately 4700 students enrolled in the Engineering and Computer Science (ECS) programs at CSUF as of Fall 2020, with many of them as first-year (freshman) students in the ECS majors.

Specifically, in the 2018-2019 school year, 134 participated in an ASSURE-US activity, and 76 consented to join the ASSURE-US study/research. For the 2019-2020 school year, an additional 167 students applied to join ASSURE-US, but only 56 consented to participate in the ASSURE-US study/research.

In the 2018-2019 school year, among ASSURE-US students:

- 34% are female, 66% are male
- 51% are Computer Science majors
- 21% received no financial aid, 11% receive California College Promise Grants, 74% receive Cal Grants, and 58% receive Pell Grants
- 39% work more than 10 hours a week
- 47% commute 30 or more minutes to campus
- 13% are a family caretaker

Among the 2019-2020 ASSURE-US students:

- 32% are female, 67% are male
- 49% are Computer Science majors
- 30% received no financial aid, 5% receive California College Promise Grants, 70% receive Cal Grants, and 55% receive Pell Grants
- 20% work more than 10 hours a week
- 35% commute 30 or more minutes to campus
- 10% are a family caretaker

The Year Two survey was administered to all the students who were in their second year of ASSURE-US program (2019-2020). Among students who responded to it, 68% reported attending the ASSURE-US orientation, 35% attended a resource workshop, 11% participated in an ECS Lab Tour, and 32% participated in Student Teacher Interaction Council events (See Figure 1).

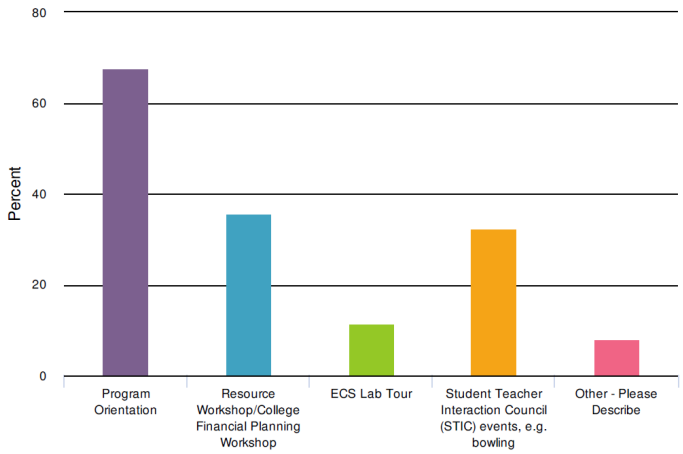

Figure 1. Student Reported Participation in ASSURE-US Events

Each student who participated at a STIC event was given the chance to participate in opportunity drawings for up to 50 gift cards, one per student. Most of the gift cards were $25 gift card for Amazon. The students who participated in at least two STIC events were give the opportunity to apply for scholarships and textbook support. In terms of financial support, 3% reported receiving an ASSURE-US scholarship, 18% reported receiving textbook support, 38% received gift cards, and 52% reported receiving no financial support (See Figure 2).

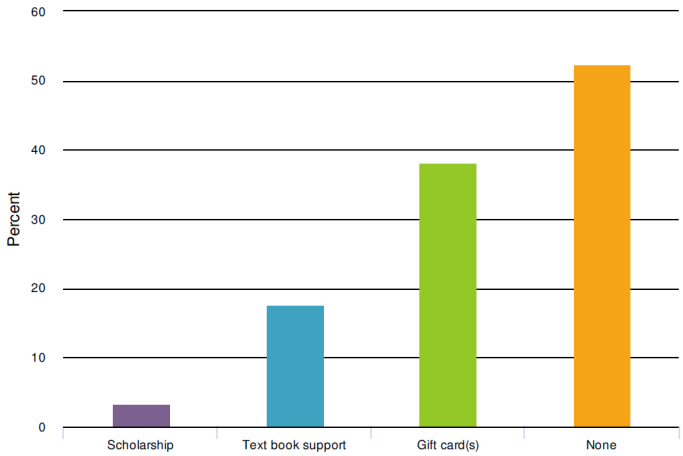

Figure 2. Student Reported Receipt of Financial Support

The students completed a short survey after each event and after the summer research experience. The questions included in the survey request information regarding the type of the event, how much they benefitted from the event in terms on meeting new people, learning new strategies towards studying, and learning new things about the resources available in campus, how meaningful was the interaction with the speakers, faculty or staff participating in the event, how connected they felt towards the students and the faculty involved in ASSURE-US program, as well as the opportunity to leave comments regarding what they like the best or was most beneficial, and how the event can be improved. These questions tie in directly to the first two research questions, with the assumption that the summer research experience provided by the faculty is directly related to the field-based experience of the faculty.

b) Results from faculty-student social interaction activities

Students reported that they valued interactions with faculty members, program-sponsored mentoring, financial assistance (even when limited), and information about resources on campus. Opportunities to meet with other students and faculty members, especially in social settings, was welcomed and valued, although many students reported having difficulty with events conflicting with their schedule. The students who missed the events had the opportunity to reach out to the peer mentors in Computer Science and Computer Engineering, but based on the discussions with the peer mentors, very few took on this opportunity. Since starting with Fall 2020 the events were held virtually on zoom, we decided to record the events, with the permission of the participants, post them on ASSURE-US website, and send an email to the stu8dents with the link to the recording. If the events will continue to be held virtually, we will continue regding them and make them available to students. If the events will be held in person, we will seek help from the College to have it recorded and be made available to the students.

Selected comments and suggestions students made in interviews and surveys about the overall program and their experience include:

- There was not much to explore in STEM in my high school, so I appreciate the opportunities to see more outside of just my classes
- I really like how the program sends reminders about events a lot and that everything is easy to join
- I enjoyed the social events
- I appreciated the opportunities for students to talk to professors and to gain connections with fellow students inside our major
- I like the concept of the program a lot. Unfortunately, the events never lined up with my schedule
- Overall, I think they do a lot, it's just the scheduling that would help it all come together, e.g. maybe holding three small workshops instead of one big one
- Balancing family and school is a challenge; I help out with driving my brother and cousin because my mom doesn't really drive, so attending ASSURE events is a challenge
- The mentorship program at Fullerton helps me a lot
- I haven't been able to participate in as many activities as I had hoped; really liked the social event I attended
- I'd suggest having workshops you have to register for so you have to set aside time for it, maybe once every two or 3 weeks; perhaps have a potluck with nothing to discuss, just a social time
- Voucher was really cool; Amazon trip cool
- Biggest challenge: my health and my family; hard to bring that up with my professors who are used to just talking about content…one of my friends got a voucher for free textbooks, which would be helpful…I find myself debating whether or not to buy a textbook; textbook probably would have helped.

Students also reported that they were very interested in being mentored by faculty, specifically "with similar backgrounds" as them. Some suggested inviting potential faculty mentors to view and exchange information during the Summer Research Symposium.

In March, however, the CSUF campus was closed due to COVID-19 on short notice, and all courses were moved online, thereby interrupting the face-to-face components of the ASSURE-US project. The STIC events scheduled for Spring 2020 were canceled due to inability of the faculty organizing these events to held online on short notice. Starting with Fall 2020, the STIC events were held online, were recorded, and made available to students unable to participate.

c) *Results from Summer Research Program*

The SURE program in Summer 2019 was a 5-week paid program and the students had to work for up to 10 hours per week to gain the necessary research experience. The decision of providing only up to 10 hours was due to the fact that the program aligned with the summer semester A, during which the students could take classes in their major.

Students who participated in summer research found it to be a valuable experience, as reported in the initial findings below, resulting in stronger commitment to their majors, increased understanding of professional work in their field, and other outcomes.

Students who participated in the Summer Research Experience (SURE) had the longest and strongest ASSURE-US program experience and it shows in the initial results. Representative responses from SURE participants about what they gained from the experience include, "I learned what my passion is" and "I learned Python and how to navigate Linux operating systems."

Additionally, key reported outcomes from SURE include:

- 79% believe that they contributed something of value to the project
- 92% report that their role involved doing real science, technology, engineering, or mathematics
- 79% report being more committed to my major as a result of SURE
- 86% report having a better understanding of what professionals in my field of study do because of SURE

Shown in Table 1 are the student opinions regarding the summer research experience in ASSURE-US.

Additionally, student suggestions for improvement included:

- Providing more for the summer research experience
- Providing additional/expanded material to learn during and in preparation for the experience
- Having more projects in an expanded number of fields
- Increasing the number of students participating
- Promoting/increasing collaboration among summer research students
- "Making the research program longer to continue to build on what I learned"
- Proving "examples of data science projects would help students understand what their end goal should be"

Furthermore, ASSURE-US entered Year Two with an updated implementation plan based on the experience gained in Year One, conducting events as planned and pursuing gateway course extensions and faculty professional learning. In March, however, the CSUF campus was closed due to COVID-19, and all courses were moved online, thereby interrupting the face-to-face components of the ASSURE-US project. The summer 2020 Summer Research Experience was cancelled due to campus and lab closures from March 2020 forward in response to COVID-19.

Table 1. SURE 2019 Student Reported Outcomes

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I believe that I contributed something of value to the project					
Count	4	7	2	1	0
Row %	29%	50%	14%	7%	0%
My role involved doing real science, technology, engineering, or mathematics					
Count	9	3	1	0	0
Row %	69%	23%	8%	0%	0%
The results of my work were or will be incorporated into the larger research project that my research supports					
Count	2	3	7	2	0
Row %	14%	21%	50%	14%	0%
I enjoyed the summer research experience					
Count	8	4	2	0	0
Row %	57%	29%	14%	0%	0%
The SRE changed how I think about courses in my major					
Count	6	2	4	2	0
Row %	43%	14%	29%	14%	0%
As a result of the SRE, I am more committed to my major					
Count	6	5	3	0	0
Row %	43%	36%	21%	0%	0%
As a result of the SRE, I have a better understanding of what professionals in my field of study do					
Count	6	6	2	0	0
Row %	43%	43%	14%	0%	0%
The SRE was a good use of my time					
Count	9	3	2	0	0
Row %	64%	21%	14%	0%	0%
My advisor helped me understand my role on the project					
Count	6	6	2	0	0
Row %	43%	43%	14%	0%	0%
My advisor helped me understand the science, technology, engineering or mathematics required for the project					
Count	4	7	1	2	0
Row %	29%	50%	7%	14%	0%
My advisor was open and accessible during the SRE					
Count	3	8	1	2	0
Row %	21%	57%	7%	14%	0%

4. Conclusion and Future Work

The faculty-student interaction, and summer research program in ASSURE-US provided a great learning opportunity for ECS lower-division students, especially first-year freshman students to learn about the college life and gain hands-on experience with research activities and real-world examples work. Students reported that they valued interactions with faculty members

and experienced experiential learning to maximize their knowledge learned in the class. Moreover, they are motivated to learn and explore the new knowledge within a clear picture about their future career. This paper summarizes the observations, student outcomes as well as lessons learned for the first-year faculty-student interaction, and summer research program in ASSURE-US. Preliminary data showed that positive impact has been made to first-year freshman students for retaining them in the ECS majors.

Additionally, due to the outbreak of COVID-19 in March 2020, the CSUF campus was closed, and all courses were moved online, thereby interrupting the face-to-face components of the ASSURE-US project activities. As a result, data are currently collected to study how COVID-19 has impacted the faculty student interaction and summer research experience of first-year (freshman) students enrolled in the ASSURE-US program, which will be the future work planned for this project.

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