

## See It, Do It, Learn It: Integrating Experiential Learning into High School Engineering Outreach Programs

### **Dr. Sharnnia Artis, University of California, Irvine**

Dr. Sharnnia Artis is the Assistant Dean of Access and Inclusion for the Henry Samueli School of Engineering and Donald Bren School of Information and Computer Sciences at the University of California, Irvine. She is responsible for programs at the pre-college, undergraduate, and graduate levels to facilitate the recruitment, retention, and overall success of students from traditionally underrepresented groups in engineering and information and computer sciences. Dr. Artis has 20 years of experience working with education and outreach programs in engineering and over 40 publications in STEM education and outreach. Prior to joining UC Irvine, she was the Education and Outreach Director for the Center for Energy Efficient Electronics Science at the University of California, Berkeley. Previously, Dr. Artis spent nine years at Virginia Tech providing program and student support for the Center for the Enhancement of Engineering Diversity and has four years of industry and government experience as a Human Factors Engineer. Dr. Artis holds a B.S., M.S., and Ph.D. in Industrial and Systems Engineering from Virginia Tech.

### **Dr. Gregory N. Washington, George Mason University**

Gregory Washington is Professor of Mechanical and Aerospace Engineering and the Stacey Nicolas Dean of the Henry Samueli School of Engineering at the University of California Irvine. Professor Washington has been involved in multidomain research for the last 20 years. He is the first African-American Dean of Engineering at any of the University of California, Campuses. His core area of interest lies in the area of dynamic systems: modeling and control. During this time he has been involved in the following applications: the design and control of mechanically actuated antennas, advanced control of machine tools, the design and control of Hybrid Electric Vehicles, and structural position and vibration control with smart materials. He has written more than 150 technical publications in journals, edited volumes, and conference proceedings and is internationally known for his research on ultra-lightweight structurally active antenna systems and other structures that involve the use of "smart materials". Professor Washington has served on several advisory boards to include the Air Force Scientific Advisory Board and the National Science Foundation Engineering Advisory Board. He currently serves on the Public Policy Committee of the ASEE Engineering Deans Council. Professor Washington received his BS, MS and PhD degrees from NC State.



**See It, Do It, Learn It:**

# Integrating Experiential Learning into High School Engineering Outreach Programs

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Stacey Nicholas Dean of Engineering

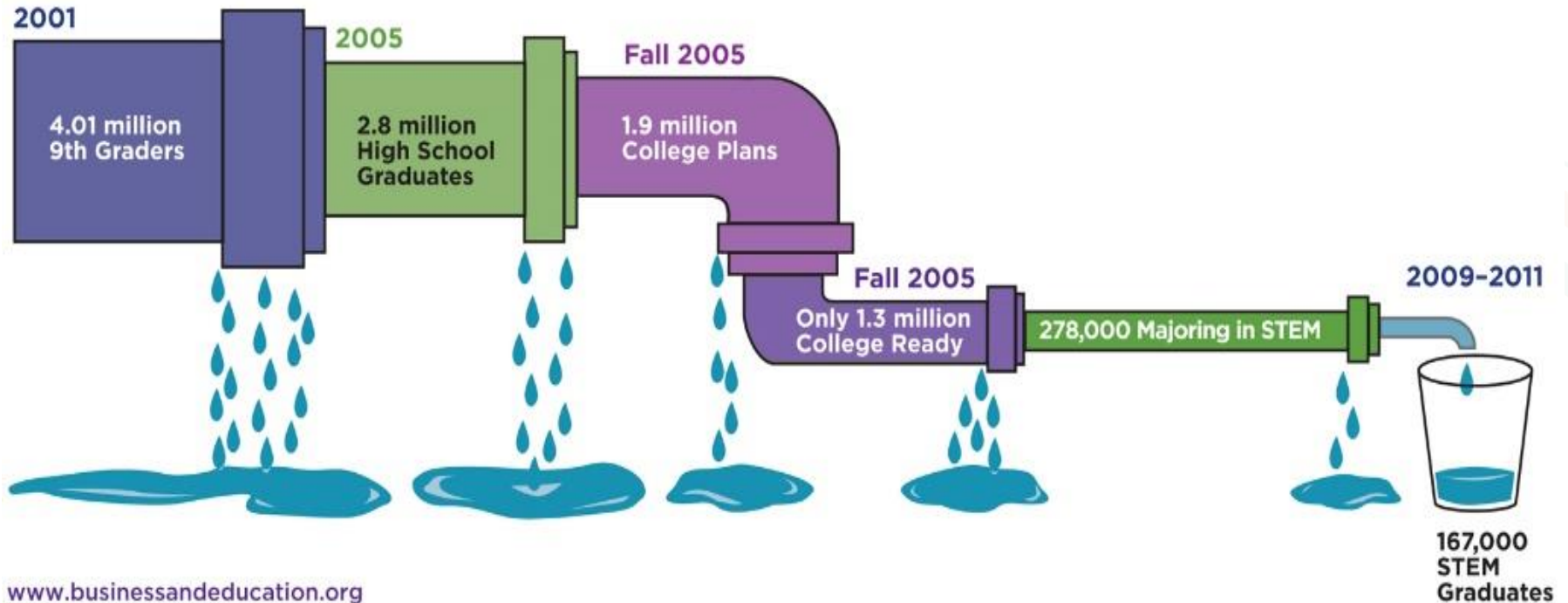
**Samueli School of Engineering | University of California, Irvine**



# Challenge



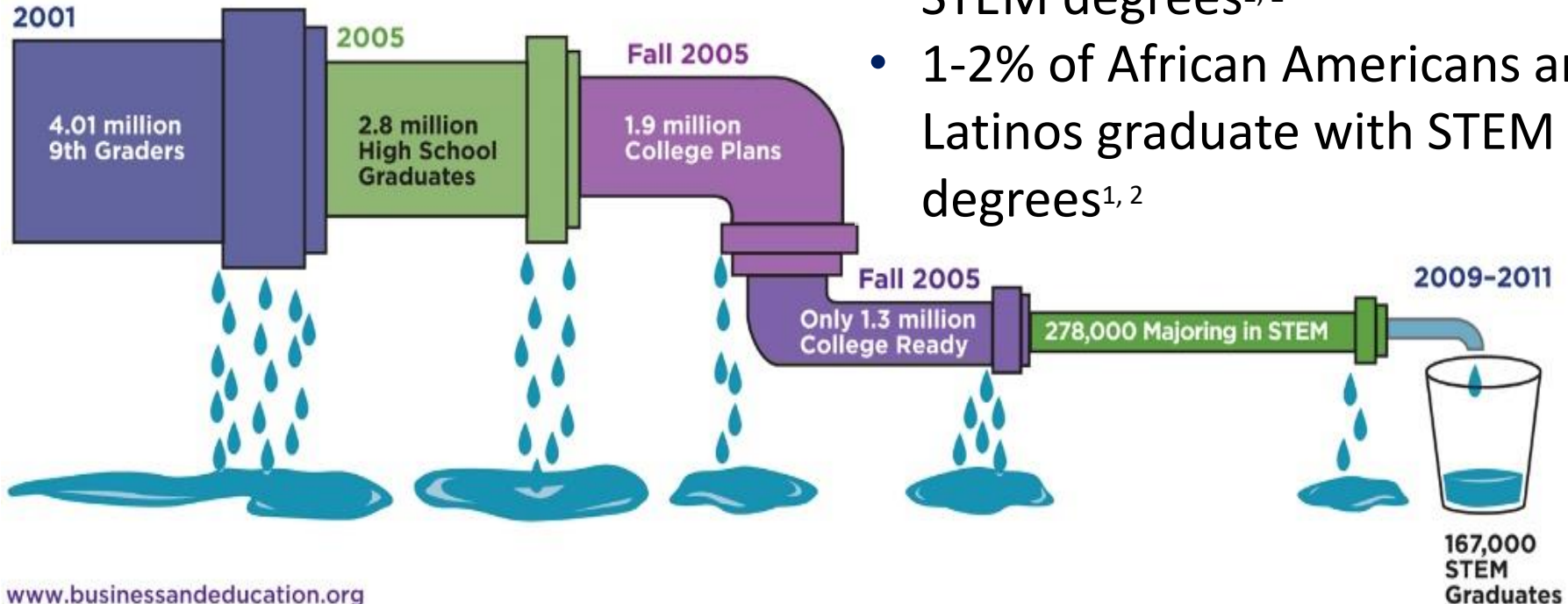
## A Leaking STEM Pipeline



# Ten Years After Entering High School

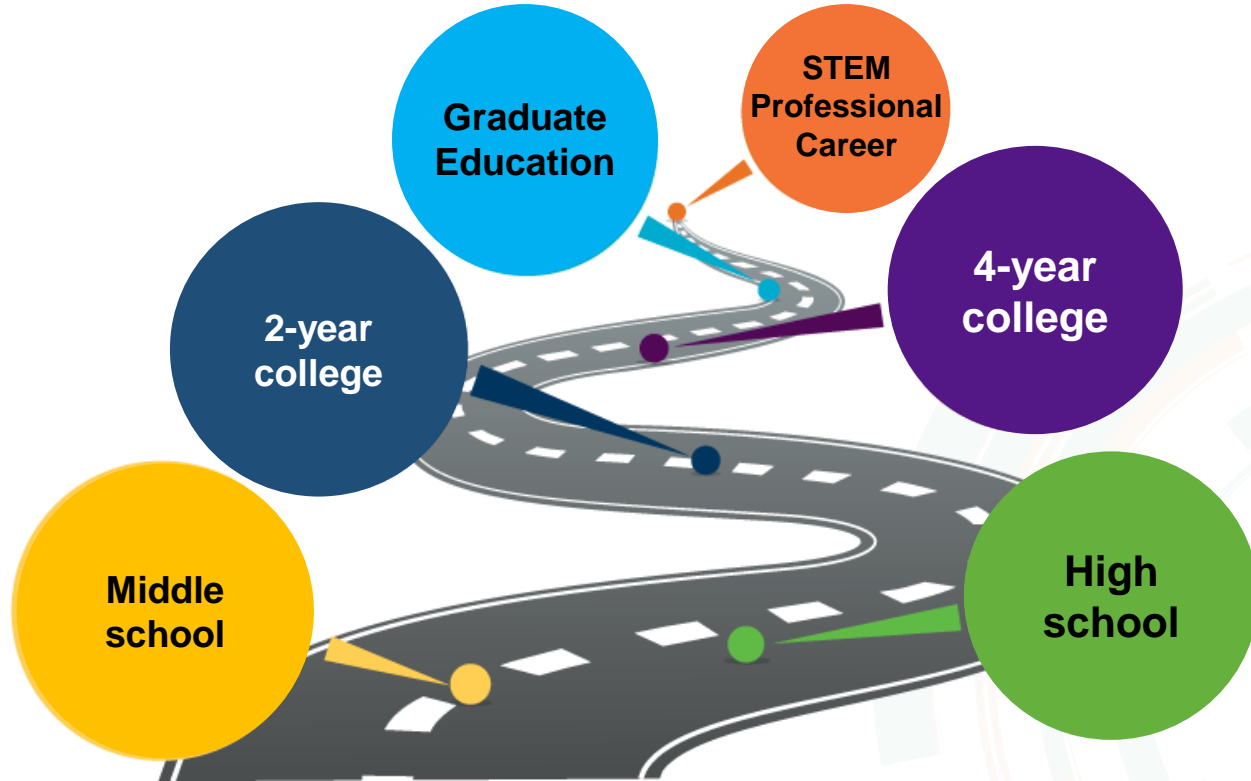


## A Leaking STEM Pipeline



- 4% of 9th graders graduate with STEM degrees<sup>1, 2</sup>
- 1-2% of African Americans and Latinos graduate with STEM degrees<sup>1, 2</sup>

# Move from Leaky Pipeline to Pathways to STEM



# Move from Leaky Pipeline to Pathways to STEM



Graduate  
Education

STEM  
Professional  
Career

- **Experiential learning**
- **Engagement, Capacity and Continuity  
Trilogy for Student Success (ECC Trilogy)**

Middle  
school

High  
school



# What is Experiential Learning?



- Learn by doing and reflecting<sup>3-4</sup>
- Enhances students' interest in STEM<sup>5</sup>
- Helps students see and appreciate more clearly the links between science and everyday lives<sup>6</sup>

# Engagement, Capacity, and Continuity Trilogy for Student Success (ECC Trilogy)<sup>7-10</sup>



## Engagement



**Increase awareness,  
interest and  
motivation in STEM**

## Capacity



**Cultivate skills to advance  
to rigorous STEM content**

## Continuity



**Continue engagement and  
tracking to support  
advancement to and  
through STEM**



# Access Summer Program to Inspire Recruit and Enrich (ASPIRE)



- Length of program: Two-week residential and non-residential program
- Participants: High school students
- Experiential-learning pedagogy: design, code, build, test, and 21<sup>st</sup> Century Skills
- Activities: Hands-on project, facility tours, workshops and panels
- Pre- and post-program evaluation
- Community of support

# Program Goals

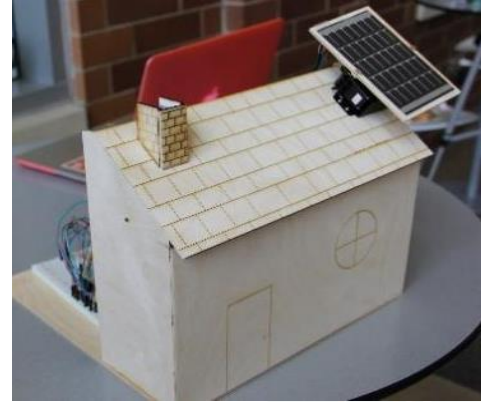
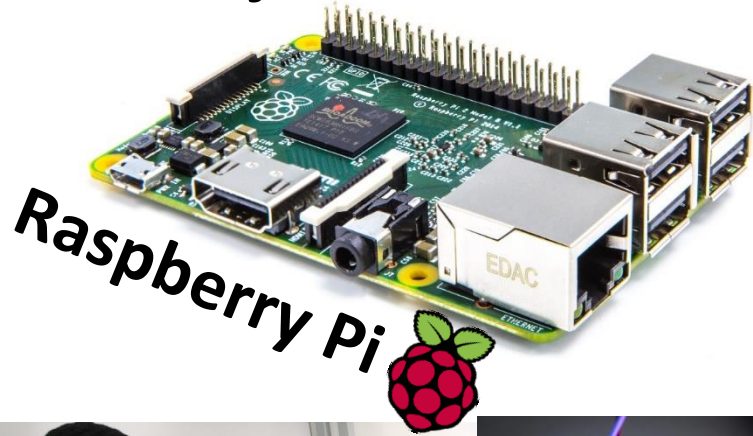


- Increase the number of women and students from underrepresented ethnic and racial groups in engineering through experiential learning
- Expose students to Internet-of-Things (IOT)
- Teach students how to code in Python using Raspberry Pi
- Allow students to apply the engineering design process through applied project

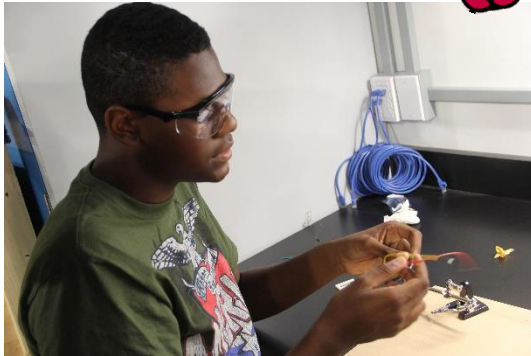
# What is Experiential Learning?



## Select Projects



*Environmental  
Engineering*  
**Solar Panel Sun  
Tracker**



*Biomedical  
Engineering*  
**The Pulse Wearable  
Device**



*Electrical and  
Computer Engineering*  
**Intellock Project**

# ECC Trilogy: Engagement



- Exposure to Internet-of-Things (IOT)
- Panels featuring STEM professionals from industry and academia
- Admissions and financial aid workshops
- Major presentations



# ECC Trilogy: Capacity



- Learn python using Raspberry Pi
- Apply engineering design process through hands-on project
- Cultivate 21<sup>st</sup> century skills through projects, teamwork, and technical presentations





# ECC Trilogy: Continuity



- Program reunions
- STEM events at UCI
- College preparation webinars
- Internship opportunities



- Local organizations
  - OC STEM
  - Faith-based organizations
  - Sororities and fraternities
  - High school teachers and counselors
  - High school programs

## Strategies

- Emails
- Flyers
- Information sessions
- Word of mouth

# Program Participants



- Over 120 HS participants in past 4 years
- Average Cumulative GPA 3.66
- Demographics data from last 4 years

Gender	
Male	56%
Female	44%
From Underrepresented Minority Group in STEM*	83%
First Generation	34%
Eligible for Free or Reduced-Cost Lunch	17%

*\*Program includes African-Americans, Latinos, Hispanics, and Native Americans in the underrepresented minority group category.*



# Program Schedule – Week 1



Week 1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Time	July 21, 2019	July 22, 2019	July 23, 2019	July 24, 2019	July 25, 2019	July 26, 2019	July 27, 2019	
7:00 AM		Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	
7:30 AM		Staff Meeting	Staff Meeting	Staff Meeting	Staff Meeting	Staff Meeting		
8:00 AM		AM Check-in	AM Check-in	AM Check-in	AM Check-in	AM Check-in		
8:30 AM		Intro to IoT & Raspberry Pi	Intro to Programming Raspberry Pi GPIO with Python	Safety Training	FABWorks/Solid Works	School of Eng Presentation	School of ICS Pres.	Week 1 Rehash and Prepare for Trip
9:00 AM								
9:30 AM		Lets Get Physical: Scratch and Python	Proj Team Meeting (Sketch Plan)			Admissions	Boomers	
10:00 AM								
10:30 AM		Lunch	Lunch	Lunch	Lunch	Lunch		
11:00 AM								
11:30 AM		Staff Check-In	Energizer	Energizer	Energizer	Energizer	Energizer	Travel to UCI
12:00 PM								
12:30 PM		Student Check-In	Sense Hat, Explorer Hat, and Selfies!	SolidWorks	SolidWorks Sketch/Project Programming	FABWorks/Solid Works	Rocketry Facility Tour	Student Olympics - Prelims
1:00 PM								
1:30 PM	Parent Welcome Meeting	Intro Project Creation			FABWorks/Solid Works	Financial Aid/UROP		
2:00 PM								
2:30 PM	Staff/Student Meet (Icebreaker)	Dinner	Dinner	Dinner	Dinner	Dinner	Dinner	
3:00 PM								
3:30 PM	Campus Tour	Team Meetings/Project Reveal/Supply Additions	Team Meetings/Project Programming	Team Meetings/Project Build	Team Meetings/Project Build	Student Olympics Sign-Up/Rules/Setup	Student Olympics - Finals	
4:00 PM								
4:30 PM	Dinner	Free Time	Free Time	Free Time	Free Time	Free Time		
5:00 PM								
5:30 PM	Program Overview	Free Time	Free Time	Free Time	Free Time	Free Time		
6:00 PM								
6:30 PM	Games at the Dorm	Free Time	Free Time	Free Time	Free Time	Free Time		
7:00 PM								
7:30 PM	Curfew	Curfew	Curfew	Curfew	Curfew	Curfew	Curfew	
8:00 PM								
8:30 PM	Curfew	Curfew	Curfew	Curfew	Curfew	Curfew	Curfew	
9:00 PM								
9:30 PM	Curfew	Curfew	Curfew	Curfew	Curfew	Curfew	Curfew	
10:00 PM								

# Program Schedule – Week 2



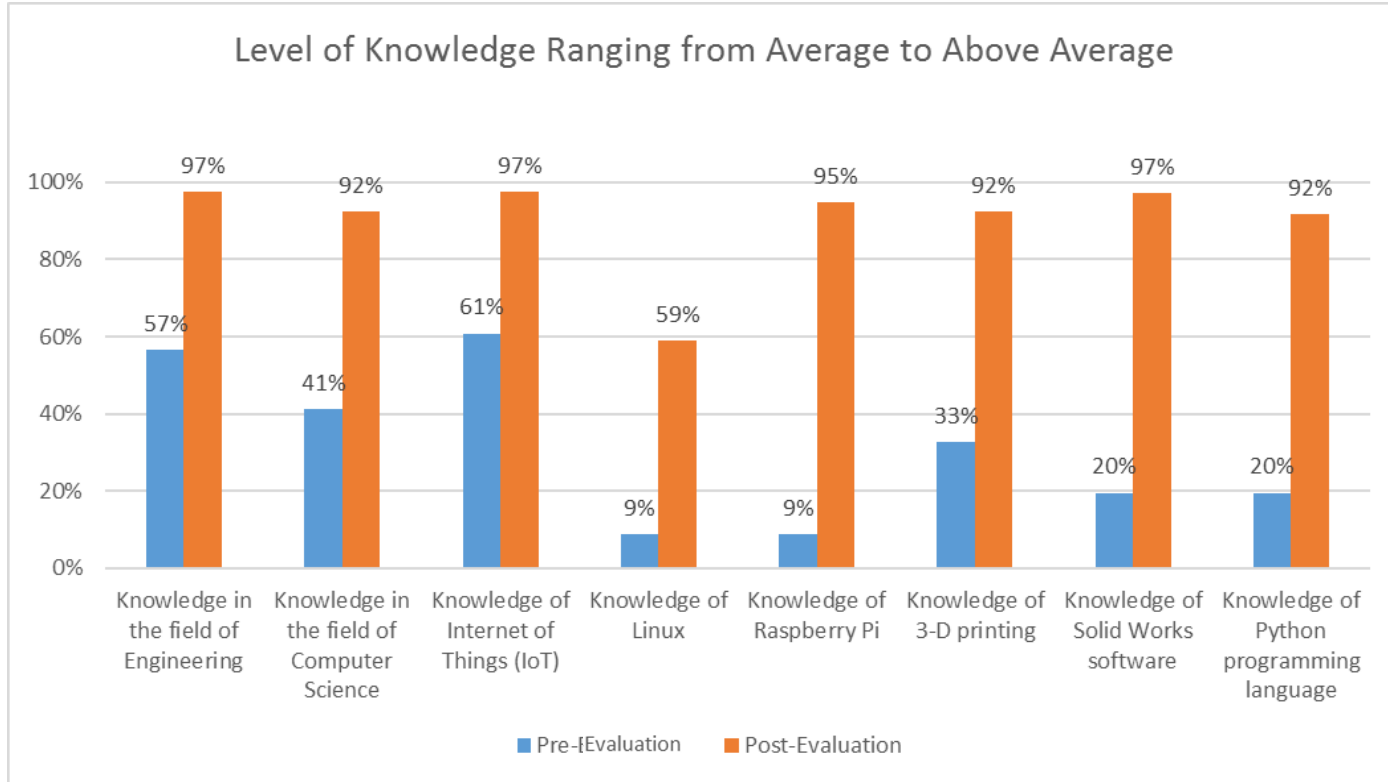
Week 2 Time	Sunday July 28, 2019	Monday July 29, 2019	Tuesday July 30, 2019	Wednesday July 31, 2019	Thursday August 1, 2019	Friday August 2, 2019
7:00 AM	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast
7:30 AM						
8:00 AM	Staff vs. Students - Gaming	Staff Meeting	Staff Meeting	Industry Field Trip	Staff Meeting	Staff Meeting
8:30 AM		AM Check-in	AM Check-in		AM Check-in	AM Check-in
9:00 AM		Project Time	Elevator Pitch/Poster Build (with Industry) - 12pm turn-in		Revise Posters and Presentations (with teammate)	Rooms Inspected by RA
9:30 AM						
10:00 AM						
10:30 AM	Check Out					
11:00 AM						
11:30 AM						
12:00 PM	Lunch	Lunch	Lunch	Lunch	Lunch	Symposium and Presentations at the University Club
12:30 PM						
1:00 PM	Staff vs. Students - Basketball	Energizer	Energizer	Industry Field Trip	Energizer	
1:30 PM		Esports	Create Presentation (with Industry) - 5pm turn in		Presentaion Practice (Cohort Rehearsal)	
2:00 PM						
2:30 PM						
3:00 PM						
3:30 PM						
4:00 PM						
4:30 PM						
5:00 PM						
5:30 PM	Dinner	Industry Dinner	Dinner	Dinner	Dinner	
6:00 PM						
6:30 PM						
7:00 PM	Staff vs. Students - Pong	Project Time	Project Status Display (with Industry)	Project Time	Project Time	
7:30 PM						
8:00 PM		Free Time	Free Time	Free Time	Free Time	
8:30 PM						
9:00 PM						
9:30 PM						
10:00 PM	Curfew	Curfew	Curfew	Curfew	Curfew	

# Program Assessment



- Evaluation: Pre- and post-program survey
- Metrics
  - Knowledge of...
    - Engineering
    - Computer Science
    - Internet of Things
    - Linux
    - Raspberry Pi
    - 3-D Printing
    - Solid Works
    - Python Programming Language
  - Confidence to succeed in engineering and computer science

# Pre & Post Program Results



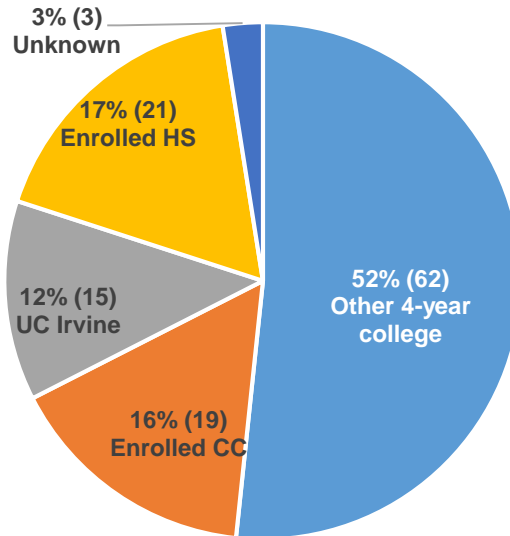
**92%** of the participants stated that the program made them feel confident in their abilities to perform tasks that will allow them to succeed as a student in the fields of Engineering and Computer Science.

- “ASPIRE has changed my interest in engineering and STEM into a sure thing by having all the speakers and seeing so many of my peers.”
- “EECS (Electrical Engineering and Computer Sciences) used to be my backup major, but I've become a lot more interested in it since I started ASPIRE.”
- “Before I came here I was debating between civil and mechanical engineering, but after going to this camp, I realized that civil engineering isn't quite cut out for me, but materials is maybe a better choice.”
- “It showed me all the hard work everyone (does) and the problems engineers deal with. So it gives me a drive to work harder.”

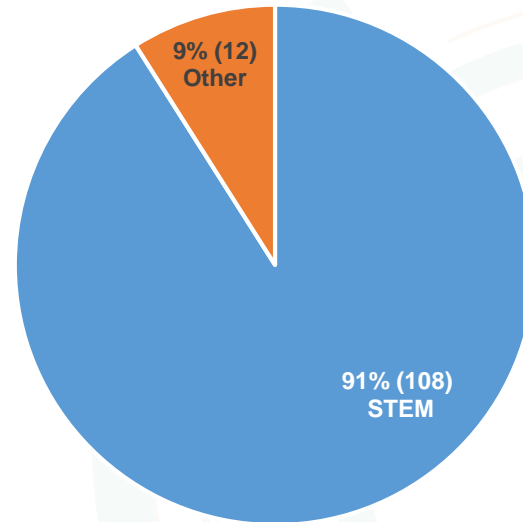
# Where are they now?



## Education Status



## Major/Major of Interest



# Where are they now?



- Cal Poly Pomona
- Cal Poly San Luis Obispo
- CSU Fullerton
- CSU Fresno
- CSU Los Angeles
- CSU Long Beach
- Massachusetts Institute of Technology
- Morehouse College
- New York University
- Purdue University
- San Jose State University
- UC Berkeley
- UC Davis
- UC Riverside
- UC Santa Cruz
- UC Irvine
- UC Los Angeles
- UNLV
- Worcester

**100% (15) of ASPIRE and INSPIRE alumni attending UC Irvine are in the Donald Bren School of Information and Computer Sciences or Samueli School of Engineering.**



# Challenges and Lessons Learned



- **Recruitment:** Partnerships with high schools, community groups, and industry
- **Parental engagement:** End-of-program celebration & workshops
- **Funding:** Sustainable funding model
- **Personnel:** Train-the-trainer program
- **Scale and Replicate:** Expand space and adapt new technology
- **Evaluation:** Measuring learning

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# Questions?

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