

# EXPANDING OPPORTUNITIES IN COMPUTER SCIENCE AMONG GIRLS OF COLOR: AN EXAMINATION OF AN A.P. PREPARATORY COMPUTER SCIENCE INTERVENTION



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# INTRODUCTION AND PURPOSE



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# Context

- ❑ Vast underrepresentation of African Americans, Latinos, and women in Computer Science.
  - ❑ African-Americans and Latinos make up 39% of the U.S. school-aged population, yet they comprise just 12% of all AP Computer Science exam takers.
  - ❑ African Americans and Latinos combined comprise just 9% of the entire computing workforce and make up just 6% of Computer Science faculty.
  - ❑ African American and Latina women combined account for just 5% of all computer science degree earners and 2% of the computing workforce nationwide.
- ❑ Women of color in STEM fields experience the “double-bind” of having the combination of two marginalized and negatively stereotyped identities (Malcom, Hall & Brown, 1976).
- ❑ Efforts targeting women or initiatives focused solely on underrepresented racial groups may overlook differences in experiences, identities, and outcomes at the intersection of race and gender.

# Purpose and Research Questions

- This study aimed to:
  - Address contextually-specific experiences of girls of color in computer science
  - Examine the impact of a computer science intervention in order to provide data to support a replicable model for intervention
- Research Questions
  - To what extent does this computer science intervention impact computer science knowledge, attitudes, and college and career aspirations among girls of color?
  - Does this intervention impact the exposure to diverse role models and peers, endorsement of negative racial and gender stereotypes about STEM ability, identification with computer science, and leadership skills among girls of color?
  - To what extent does the intervention have lasting effects on girls of color, and after a follow-up one year later, do the intervention effects persist?



# THEORETICAL & CONCEPTUAL FRAMEWORK



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- Effective STEM Interventions for Underrepresented Students
  - Gandara & Bial, 2001; Valla & Williams, 2012
    - Outline 10 effective features of successful K-12 intervention programs for underrepresented groups
  - Little is known empirically about effective computer science interventions which address the specific experiences of girls of color.
- Culturally Responsive Computing
  - Goode & Margolis, 2011; Scott, Sheridan & Clark, 2014; Scott & White, 2013
    - Approach to devising technology education that aims to:
      - Motivate and improve STEM learning experiences
      - Provide a deeper understanding of heritage and vernacular culture, empowerment for social critique, and appreciation for cultural diversity
      - Diminish the separation between the worlds of culture and STEM
      - Use technology to not only respond to identity issues, but also to satisfy pedagogical demands of the curriculum



## BARRIERS

Lack of Access to CS Courses

Lack of Access to Diverse Peers and Role Models in CS

Social/Psychological Barriers (Identification, Belonging, Stereotypes)

## Culturally Relevant and Responsive Pedagogical Framework

### INTERVENTIONS

- Multi-year computer science course sequence
- Engaging and culturally relevant curriculum content
- Diverse STEM role models, peers, and instructors
- Leadership growth activities inside and outside of the CS classroom

### SHORT-TERM OUTCOMES

- Computer science knowledge
- Computer science attitudes
- Identification with computer science
- Belonging in STEM
- Negative racial stereotypes (-)
- Negative gender stereotypes (-)
- Access to diverse STEM/CS role models
- Network of STEM/CS peers
- Leadership skills
- Computer science college and career aspirations

### LONG-TERM OUTCOMES

- Declare CS major
- Persist in CS
- Graduate with CS degree



# METHODOLOGY



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# Program Context

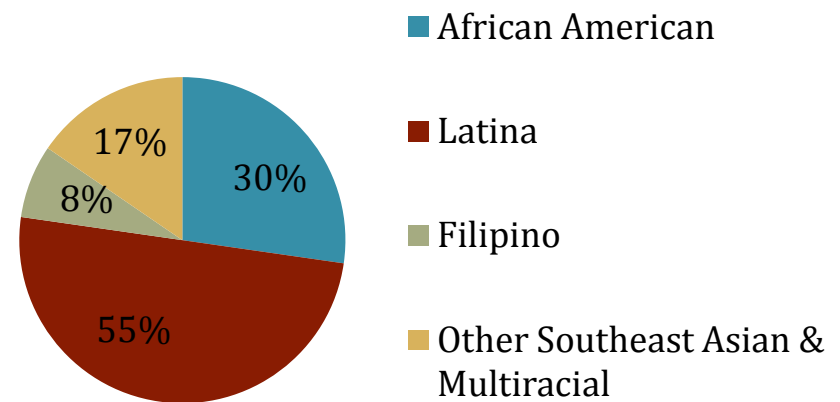
- ❑ Computer science intervention within a five-week, three-year STEM-focused summer program
- ❑ Four sites in Northern and Southern CA
- ❑ Serves low-income, first-generation, high school students of color (50% female)
- ❑ Computer science programming includes:
  - A three-summer computer science course sequence, providing repeated, sequential preparation
  - Culturally relevant curriculum to make computing relevant to the lives and interests of girls of color (adapted from Exploring Computer Science curriculum),
  - Exposure to diverse computer science role models and instructors
  - Community-building and leadership development activities



# Participants

- N=108
- **Grade:**
  - 10<sup>th</sup> (37%)
  - 11<sup>th</sup> (45%)
  - 11<sup>th</sup> (18%)
- **Socioeconomic Status:**
  - FRPL-eligible: (84%)
  - First-in-Family to complete college (82%)
- **Type of School:**
  - Public/charter school 94%
  - Private school 6%
- **Student Achievement:**
  - Average incoming math grade A-

**Race/Ethnicity**



# Study Instrument & Data Analysis

- Comprehensive online pre-and post-program survey. Scales included:
  - Attitudes toward Computer Science ( $\alpha=.88$ )
  - Identification with Computer Science ( $\alpha=.68$ )
  - Access to Diverse Role Models in STEM ( $\alpha=.81$ )
  - Computer Science Aspirations ( $\alpha=.81$ )
  - Access to Networks of STEM Peers ( $\alpha=.84$ )
  - Leadership Skills ( $\alpha=.86$ )
  - Endorsement of Racial Stereotypes about STEM ability ( $\alpha=.82$ )
  - Endorsement of Gender Stereotypes about STEM ability ( $\alpha=.89$ )
- These scales were developed in consultation with existing literature attempting to measure beliefs about academic abilities and stereotypes within STEM, and were adapted for use with an adolescent population.
- Paired-samples T-tests were run to determine whether mean scale values for computer science knowledge, attitudes, aspirations, racial and gender stereotypes, identification, belonging, and leadership skills changed significantly from pre- to post-intervention.



# OVERVIEW OF FINDINGS



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# Computer Science Knowledge, Attitudes, & Aspirations



- The intervention had a significant positive effect on computer science knowledge and attitudes towards computer science.
- There were small but non-significant changes in computer science college and career aspirations over the course of the intervention.
- These data extend previous findings on the effect of culturally relevant and responsive computing interventions (Scott & White, 2013) and short-term computer science interventions (Martin & Scott, 2013), by demonstrating their effectiveness with girls of color.

# Social/Psychological Barriers

- Results indicate that the intervention had a significant positive effect on identification with computer science and girls were more likely to see computer science as something that was relevant to their lives and their community.
- Girls' leadership skills, access to diverse role models, and networks of peers in STEM all increased significantly from pre- to post-intervention.
- The endorsement of negative racial and gender stereotypes among girls of color decreased, although not significantly.
- These findings indicate that identification with computer science and leadership skills can be increased among girls of color within a culturally relevant computer science intervention.



# Examining the Longevity of Intervention Effects: One Year Later

- Intervention with the same participants one year later:
  - Significant increases from pre-post intervention were shown in girls' knowledge of computer science, computer science aspirations, and computer science self-efficacy.
  - Girls' attitudes toward computer science, perceptions of computer science, access to diverse STEM role models, and access to computer science support networks all increased (though not significantly) from pre-post intervention.
  - The endorsement of negative gender stereotypes among girls of color decreased significantly. The endorsement of negative racial stereotypes among girls of color decreased, although not significantly.



# Significance

- Results indicate that this culturally-relevant computer science intervention for girls of color increased computer science knowledge, attitudes towards computer science, identification with computer science, access to diverse role models and networks of STEM/CS peers, and leadership skills.
- Future research will examine long-term effects of this intervention, including AP CS coursetaking, college major, persistence, and degrees earned.
- This research:
  - Has implications for practitioners in the design of interventions targeting girls of color.
  - Provides preliminary data for a model for effective programming for girls of color in computer science which can be tested and replicated.
  - Indicates that culturally relevant approaches can be effective in expanding participation among underrepresented groups in computer science and ultimately diversifying the field of computing.





# THANK YOU

For more information about this study or related research and STEM programming for high school students:

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