

EXAMINING THE IMPACT OF A CULTURALLY RESPONSIVE OUT-OF-SCHOOL COMPUTER SCIENCE INTERVENTION FOR UNDERREPRESENTED HIGH SCHOOL STUDENTS

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<u>Mission</u>

Level Playing Field Institute is committed to eliminating the barriers faced by underrepresented people of color in science, technology, engineering and mathematics and fostering their untapped talent for the advancement of our nation.

SMASH Program

- 5-week, 3-summer H.S. residential program
- Includes Math, Science, Computer Science core curriculum, elective courses, youth development curriculum, access to role models and peer networks
- CS intervention includes a 3-course sequence, and academic year AP CS prep to prepare students for the AP CS A (and P) exams



Access and Underrepresentation in Computer Science

- Significant disparities in access to CS courses exist by race and socioeconomic status; Schools with high percentages of low-income, students of color are much less likely to offer CS courses
- African American & Latino students:
 - **34%** of the high-school aged population in the U.S.
 - 13% of all HS students taking the Advanced Placement Computer Science exam
- Nationwide, African Americans & Latinos <u>combined</u> account for only:
 - 17% of all computer science Bachelor's degrees earned
 - 7% of all Ph.D. degrees conferred
 - 6% of computer science faculty
 - 9% of the computing workforce nationwide



Sources: College Board, 2014; NSF, 2012, 2013; Path Not Found, 2015

Study Background and Purpose

- Given the persistent underrepresentation, there is growing momentum to broaden participation in computing, including coding bootcamps, programs, and hackathons, curriculum/course development (BJC, ECS), professional development and teacher training to broaden access (Code.org, ECS), state-level policy (ACCESS), and federal initiatives (CS for ALL)
- Yet, in this emerging field, little is known about the effectiveness of various interventions and the impact they have on underrepresented students' participation and persistence in CS.
- Further, little is known about the efficacy of computer science interventions within a culturally responsive framework and the implications for culturally responsive conceptual frameworks as models for CS interventions.
- This study examines the effectiveness of an out-of-school CS intervention for underrepresented high school students, utilizing a culturally responsive framework

Research Questions

- What impact does this computer science intervention have on computer science access, knowledge, and skills of underrepresented high school students?
- Does participation in this CS have an impact on the computer science college and career aspirations of underrepresented high school students?
- What impact does this CS intervention have on the development of computing self-efficacy and an orientation towards using computing knowledge to address issues of relevance to underrepresented communities?

Relevant Literature

- Structural and Psychological Barriers to Computer Science Participation
 - Disparities in <u>access</u> to rigorous computer science coursework (Margolis et al., 2008; Martin et al., 2015)
 - Lack of engaging and relevant computing <u>curriculum</u> (Ryoo et al., 2013; Scott et al., 2009)
 - Implicit bias and <u>stereotypical cues</u> in classroom and workplace environments (Cheryan et al., 2009, 2011)
 - Lack of diverse <u>role models and peer networks</u> in computing (Anderson et al., 2008; Cain, 2012; Goode, 2008; Zimmerman et al., 2011)
 - Perceptions of computer science as lacking <u>cultural relevance</u> (Cheryan et al., 2013; Rich, et al., 2004; Williams et al., 2007),
 - <u>Stereotype threat</u> associated with being a member of a marginalized group (Grossman & Porche, 2014; Schmader, et al., 2004; Steele & Aronson, 1995)

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Relevant Literature (cont.)

- Culturally Responsive Computing (Scott et al., 2014)
 - Describe a model and approach to designing computing experiences that aim to:
 - Motivate and improve learning
 - Provide deeper understanding of heritage & vernacular culture, empowerment for social critique, appreciation for cultural diversity
 - Diminish 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 (Eglash, et al., 2013)
 - Address digital disparity broadly by considering intersectionality, innovation, community advancement (Scott et al., 2014)



Conceptual Framework: A Culturally Responsive CS Intervention

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



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

Social/Psychological Barriers (Identification, Belonging, Stereotypes)

BARRIERS

Lack of Access to CS

Courses

Lack of Access to Diverse

Peers and Role Models in CS

Program Context & Participants

- 266 high school students attending a five-week, three-year summer STEM program across multiple sites in California.
 - Race/Ethnicity:
 - Latino (58%), African American (30%), Southeast Asian (7%), multiracial (5%)
 - Gender:
 - Female (51%), Male (49%)
 - Socioeconomic Status and Education Level:
 - 84% FRPL-eligible
 - 78% first-generation college students
 - High School:
 - 95% of students attend public or charter HS in California



Intervention Description

- A 3-summer computer science course sequence, providing repeated, sequential preparation (CS1, CS2, CS3) and an academic year AP CS preparation course for HS Seniors
- Culturally relevant curriculum to make computing relevant to the students' lives and interests (adapted from Exploring Computer Science & the Beauty and Joy of Computing curricula)
- Exposure to diverse computer science role models and instructors
- Community-building and leadership development activities
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Instruments & Analysis

- Comprehensive pre-and post CS content knowledge assessments were developed in conjunction with the CS instructors and the Curriculum Director. All students took a preand post- program CS assessment covering the following material:
 - CS1: Scratch, variables, conditionals
 - CS 2: Data mining, analysis, app development, algorithms
 - CS 3: Debugging, problem solving, HTML/CSS/Java basics
- All students also completed a comprehensive online pre-and post-program survey, which contained scales including: Understanding CS field and computing careers, attitudes towards CS, CS aspirations, Peer support networks and role models in CS, Self-Efficacy in CS, and Cultural relevance of CS.
- Pre- and Post-program assessment scores and survey results were examined using statistical analyses to compare differences in mean scores on assessments and scales (Paired-Samples T-Test). Descriptive analyses were also run.

FINDINGS: CS Access, Knowledge, Skills

- Computer Science Access, Knowledge, and Skills:
 - Students demonstrated a significant increase in familiarity with the field of CS field and computing careers, from pre- to post-program (p<.00).
 - 94% of students increased in computer science course content-based assessment scores over the course of the program
 - Students significantly increased their self-reported knowledge of CS programming languages and computer science self-efficacy

Scale	Mean (Pre)	Mean (Post)	Mean Diff	Sig. (2-tailed)
Familiarity with CS Programming Languages	2 32	3.06	0.74	00
Understanding of Computer Science Field & Computing Careers	3.74	4.23	0.49	.00
Computer Science Self-Efficacy	3.82	4.07	0.25	.00
Computer Science Support Networks	3.27	3.56	0.29	.00





FINDINGS: Aspirations and Attitudes

- Computer Science Aspirations and Attitudes:
 - Significant increases in student attitudes toward computer science and aspirations to study computer science in college and to pursue a career in computer science

Scale	Mean (Pre)	Mean (Post)	Mean Diff	Sig. (2-tailed)
Cultural Relevance of				
Computer Science	3.82	4.15	0.33	.00
Social Justice				
Orientation	4.36	4.46	0.1	.02

- Cultural/Social Relevance of Computer Science:
 - Significant increase understanding of cultural relevance of computing and orientation towards using computer science to improve communities

Scale	Mean (Pre)	Mean (Post)	Mean Diff	Sig. (2-tailed)
Computer Science Aspirations	3.38	3.62	0.24	.00
Attitudes towards Computer Science	3.79	4.24	0.45	.00

Summary and Implications

- This study demonstrates that significant increases in access, attitudes, knowledge, and aspirations can be demonstrated among underrepresented HS students in a short-term (5-week), out-of-school context
- The findings provide evidence to suggest the culturally responsive conceptual framework within which the intervention is situated is promising for producing significant increases in CS knowledge and aspirations among underrepresented groups.
- These findings contribute to literature on effective strategies for out-of-school interventions to increase exposure, preparation, success, and persistence in computer science for underrepresented high school students of color.

THANK YOU!

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