•Courses include: Core math and science (Algebra II, Calculus, Physics), and electives including Computer Science, Entrepreneurship, Media Technology

Bridging the K-12 and Higher Education Gap for Underrepresented Students of Color in Science, Technology, Engineering and Mathematics (STEM)

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Abstract

Based on a review of relevant literature and case-study data, we propose a research-based intervention framework to bridge the gap between K-12 and higher education and improve STEM outcomes among underrepresented students. This framework addresses structural and social/psychological barriers facing underrepresented students and proposes the following interventions: (1) Increasing academic preparation and college readiness for STEM coursework, (2) Providing opportunities for STEM exposure and engagement, (3) Preparing students for the college application process, (4) Providing coaching through the second year of college, and (5) Providing networks of peers, college students, and STEM professionals of color to buffer the effects of stereotype threat and prevent isolation, and disengagement. Findings from the case study of the Summer Math and Science Honors Academy (SMASH) for underrepresented high school students in California suggest that these coordinated interventions can significantly improve outcomes and bridge the gap between K-12 and higher education for underrepresented students of color in STEM.

Background

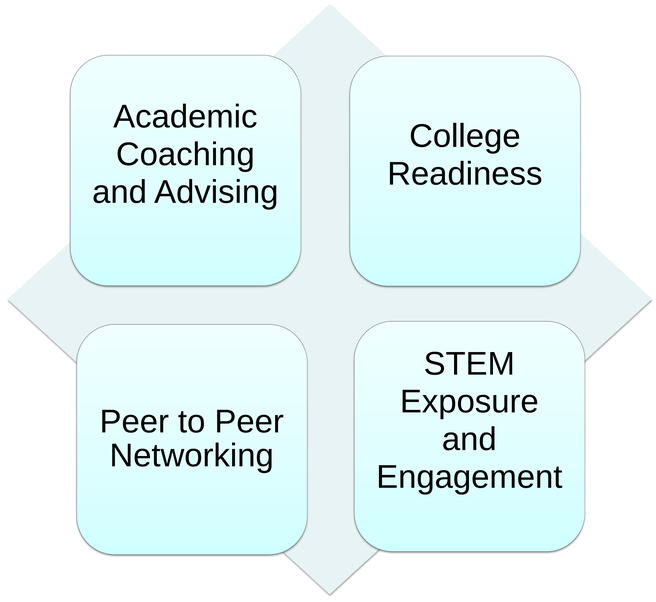
Despite projections that the fastest-growing and highest-paying jobs of the future are in the fields of Science, Technology, Engineering, and Mathematics (STEM; U.S. Department of Labor, 2009; U.S. Department of Commerce, 2011), African Americans and Latinos earn only 9% of all science and engineering degrees, and represent just 11% of the entire science and engineering workforce (NSF, 2009, 2011).

Literature suggests that the underrepresentation of people of color in STEM fields is linked to both structural barriers in educational access and opportunity, and social/psychological barriers. Within K-12 education, structural barriers include the lack of access to school funding, lab facilities, technology, high-quality teachers, and advanced coursework than their peers, limiting underrepresented students' opportunities for success in STEM (Darling-Hammond, 2004; Education Trust-West, 2012; Goode, 2010). Additionally, underrepresented students face challenges in identifying with STEM professions due to a lack of role models within the field, which can have a detrimental effect on STEM engagement and persistence (Price, 2010). As a cumulative effect of these barriers, African American and Latino students demonstrate much lower proficiency rates in science and mathematics (National Assessment of Educational Progress, 2009, 2011), are less likely to access and achieve success in advanced coursework (College Board, 2011), and demonstrate lower levels of college readiness than their peers (ACT, 2011; SAT, 2011). These outcomes have significant implications for STEM persistence in higher education and degree completion, where the best predictors of earning undergraduate STEM degrees are high levels of academic performance, number of advanced courses taken, and standardized test scores (Eagan, et al., 2010).

Within higher education, barriers facing underrepresented students of color include the lack of academic preparation, lack of role models and mentorship, a non-welcoming climate, and the psychological responses associated with being a member of a negatively stereotyped group (including lowered test performance and disengagement; Perna et al., 2008; Steele & Aronson, 1995; Thiry, et. al, 2011).

As a result, just 22% of Latino students and 18% of African American students who aspired to major in a STEM field completed a Bachelor's Degree within 5 years (Eagan, et al., 2010). Improving outcomes for underrepresented students of color in STEM must directly address the structural and social/psychological barriers facing students in both K-12 and higher education through coordinated interventions.

Intervention Framework



The **College Readiness** component provides students with vital college preparatory activities including:
- •Advanced STEM coursework
- •College counseling.
- •Financial aid and scholarship workshops.
- •SAT/ACT test preparation.

The **Academic Coaching** component provides students the opportunity to:
- •Achieve academic and personal goals.
- •Balance school and extracurricular activities.
- •Create a STEM career pathway.

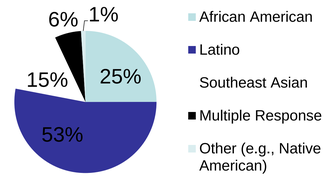
The **Peer-to-Peer Networking** component includes opportunities for:
- •Online networking with diverse peers.
- •Student-led skillshares.
- •Volunteer and civic engagement activities.

The **STEM Exposure and Engagement** component connects students to:
- • Robotic, engineering and other academic competitions.
- •Research experiences with STEM graduate students and professors.
- •STEM industry mentorships and internships.

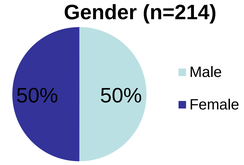
Case Study: SMASH ACADEMY

- **•214 scholars, 176 alumni**
- **•76% FRPL-eligible, 78% First Generation College**
- **•5-week, 3-year summer residential program** currently held on 4 college campuses in California (UC Berkeley, Stanford, UCLA, USC).
- **•Program includes:**
  (1) Accelerated STEM courses
  (2) Project-based, and Social Justice-oriented curriculum
  (3) College preparation courses
  (4) Exposure to STEM role models, professionals, and career opportunities
  (5) Community-building activities to promote networks of STEM scholars of color,
  (6) Coaching and tracking of alumni to ensure persistence in higher education

Race/Ethnicity (n=214)



Gender (n=214)



Methods and Findings

•Data collected from 207 current scholars and 90 SMASH alumni; Included standardized pre- and post-SMASH math assessments (MDTP), pre-post scholar surveys, and Academic year and alumni data tracking.

College Readiness
62% of SMASH scholars demonstrated an increase in mathematics readiness, and statistically significant increases in computer science knowledge and technology skills were demonstrated from pre-SMASH to post-SMASH.
Scholars demonstrated significant increased in understanding of the college applications and financial aid processes.

STEM Exposure and Engagement
Scholars demonstrated a significant increase in their access to networks of STEM peers and access to diverse role models in STEM.
At the completion of the program, 81% of students indicated their plans to declare a STEM major, and 84% indicated the desire to pursue a career in STEM.

Peer-to-Peer Networking
Significant increases were seen in exposure to networks of diverse scholars, and likelihood of maintaining relationships with SMASH peers in future.

Post-Secondary Data
100% of SMASH alumni graduated from high school, 88% were enrolled full-time in a four-year university, and 48% have declared STEM majors.

Implications/Recommendations

K-12 public education
- •Increase availability of advanced STEM courses and electives
- •Incorporate project-based, technology-integrated, culturally-responsive approaches to STEM instruction
- •Increase collaborations with higher education institutions, including bridge opportunities, networks of role models/mentors, online curriculum

Learning and STEM engagement in out-of-school settings
- •Increase availability of programs to engage students during out-of-school time and increase collaborations between K-12 and higher education institutions to provide congruent interventions.
- •Encourage public-private partnerships to increase exposure to STEM careers and role models.

Higher education retention and persistence
- •Increase opportunities for students to experience college-level coursework and campus climates through university-led initiatives and/or partnerships with K-12 and non-profits.
- •Create support networks of STEM peers and mentors for students from secondary education through graduate school.

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