EXAMINING THE EFFECTIVENESS OF A STEM-FOCUSED INTERVENTION PROGRAM FOR AFRICAN-AMERICAN MIDDLE SCHOOL BOYS

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Underrepresentation of African-American Males in STEM

- Disparities in academic outcomes between African-American males and their White and Asian peers contribute to:
  - Limited future opportunities
  - Significant loss of a talent pool for the STEM workforce
- African-American males earn only **3%** of all science and engineering college degrees across the country (NSF, 2012)
- African-American men represent just **2%** of the entire U.S. science and engineering workforce and only **1%** of faculty members in STEM departments (NSF, 2012)

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Barriers Facing African-American Male Students in STEM

- **Structural barriers**
  - Inequitable school funding (EdTrust West, 2012)
  - Lack of access to science resources and facilities (WestEd CFTL, 2011)
  - Lack of access to high-quality teachers (Darling-Hammond, 2004; U.S. Dept of Ed., 2008)
  - Inequitable access to computer science courses (Margolis et al., 2008)
  - Lack of opportunity to engage with technology to solve problems, conduct experiments, or create products (Goode, 2010; Gray, Thomas & Lewis, 2010)
  - Unequal access to advanced coursework (College Board, 2012)

- **Psychological stressors**
  - Stigmatization (Major & O'Brien, 2005)
  - Isolation (Chang et al., 2011; Perna et al., 2009)
  - Stereotype threat (Steele & Aronson, 1995)

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THEORETICAL FRAMEWORK

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Cultural Incongruity

- Research indicates that **incongruity between home culture and school context** can negatively affect the academic performance of students from diverse racial/ethnic backgrounds (Allen & Boykin, 1992; Au, 1980; Irvine, 1991; Philips, 1972; Heath, 1983). Examples include:
  - Negative experiences with **teachers** (Palmer, et. al., 2010; Valenzuela, 1997; Weinstein, 2002; Wong et al., 2003)
  - Cultural disconnect in **linguistics and interaction style** between teachers and students (Delpit, 1995; Olsen, 1997)
  - Lack of African-American male-centered **curricula and teaching** style (Nasir, 2008; Noguera, 2008)
  - Teachers' **colorblind ideologies** that result in unintentional reinforcement of Eurocentric school practices (Lewis, 2003; Pollock, 2004)
  - **Disciplinary disparities** resulting from cultural disconnect between teachers and students in the subjective interpretation of behaviors (Ferguson, 2000; HCRP, 2000; Noguera, 1995)

Culturally Relevant Pedagogy (CRP)

- Culturally Relevant Pedagogy:
  - Asserts if learning is grounded in a **familiar cultural context**, there is greater potential for improved outcomes (Allen & Boykin, 1992; Ladson-Billings, 1992)
  - Places **perspectives of culturally diverse students** at forefront & emphasizes authentically **caring teacher/student interactions** (Gay, 2000; Nieto, 2008; Valenzuela, 1999)
  - Bridges **home/school linguistic** forms (Lee, 1995)
- STEM curriculum that is culturally relevant:
  - Recognizes and **challenges inequity** (Tate, 1995)
  - Encourages development of **critical thinking**
  - Creates conditions for students to have thoughtful **analyses of community issues** (Ladson-Billings, 1995)
- CRP is proposed by a significant amount of research as a **promising practice** to decrease racial achievement gaps (Gay, 2000; Ladson-Billings, 1995)
- Yet, little research has been conducted on the impact of utilizing **CRP within STEM** education programs for **African-American males**

Study Purpose

- Significant need for effective STEM intervention programs that counteract structural & psychological barriers to STEM among African-American male students
- This study examines the efficacy of an out-of-school program designed to increase the preparation and representation of African-American adolescent males in STEM

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Research Questions

(1) How does a STEM-focused intervention program impact academic knowledge among African-American males?

(2) What impact does the program have on participants' STEM attitudes and aspirations?

(3) In what ways do diverse STEM peers and role models affect students within the program?

(4) What aspects of the program do the students view as the most impactful?

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METHODOLOGY

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Program Description

- Program met **every other Saturday** from October 2012 through June 2013
- **Curriculum**
  - Mathematics, Communication Technologies, and Computing & Mobile Apps enrichment courses
  - Youth development workshops (e.g., leadership, public speaking)
  - Integrated project-based learning, culturally relevant pedagogy, and technology
- **Role Models, Mentors, STEM Peer Networks**
  - Exposure to African-American male STEM role models (instructors and speakers)
  - Facilitation of community-building and support networks among peers
  - STEM-focused field trips

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Participants

- 27 male students
  - 6th grade: 51%
  - 7th grade: 29%
  - 8th grade: 20%
- 94% African-American, 6% Mixed Race
- FRPL-eligible: 32%
- First-generation college-bound: 30%
- Average GPA=3.20
- 88% attend California public schools

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Data Collection & Analysis

Instruments	Procedures	Analysis
Surveys	Administered online, pre-and post-program	Paired-samples T-tests to determine if mean scale values changed significantly over time.
Academic Assessments	Administered pre-and post-program, for Mathematics, Mobile Apps, and Communication Technologies	Frequencies for each item on the Mobile Apps and Communication Technologies assessment were calculated (e.g., % strongly agree/agree). Percentage change between pre and post was calculated to determine growth or stagnation. Math assessments were scored at pre- and post-program and basic analyses were conducted (% of students increasing, average gain/loss).
Focus Groups	To examine program impact, groups were held last day of the program	Transcripts were analyzed utilizing qualitative analysis software. Qualitative data were triangulated with quantitative data to synthesize findings.

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Study Instruments

- **Survey scales:**
  - Attitudes towards Math (α=.88; 2 items)
  - Identification with Math (α=.16*; 3 items)
  - Identification with Computer Science (α=.87; 3 items)
  - Attitudes toward Computer Science (α=.79; 2 items)
  - Explicit stereotypes about math and science (α=.19*; 3 items)
  - Perceived Barriers to STEM (α=.88; 6 items)
  - Interest in Pursuing Advanced STEM Coursework (1 item)
  - STEM College and Career Aspirations (α=.78; 4 items)
  - Access to Role Models (α=.88; 4 items)
  - Network of Peers (α=.62; 2 items)

  **Scale has a low alpha value, which is noted and will be revisited in future analyses.*

- **Focus group protocol:**
  - 7 questions examining student perceptions of the program
    - Sample questions include: "What did you learn from the program?" and "In what ways did the program impact how you feel about math and science?"

Academic Assessments

- Mathematics Assessment:
  - Aligned with CA state math standards
  - One grade level above students' current level

Math Items	
6th grade	50 items
7th grade	44 items
8th grade	55 items

- Mobile Apps Assessment:
  - 12 items, Self-Reported, Based on 3-point Likert scale
- Communication Technology Assessment:
  - 10 items, Self-Reported, Based on 5-point Likert scale

OVERVIEW OF FINDINGS

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Academic Knowledge

> *"I learned a deeper knowledge of STEM."*

- **Mathematics:**
  - **69%** of participants demonstrated growth in mathematics achievement from pre- to post-program
  - Average increase of **5 items**
  - **39%** increased by between **11-20 items**
  - **Significant increase** in math performance from pre- to post-program ($M = -9.4$, $SD = 16.5$; $t(19) = -2.53$, $p = .02$, two-tailed

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Academic Knowledge (cont.)

- **Communication Technologies & Mobile Apps**
  - Content areas such as mobile app proposals, user interface design, "back-end" design, digital editing, production, podcasting, website design, video game programming
- **Strong pre-post increases** for **every item**

"I learned how to connect social justice to mobile apps."

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Academic Knowledge (cont.)

Computing and Mobile Apps	PRE			POST			Pre-Post Increase (Very Good)
	Not at all	Somewhat	Very Good	Not at all	Somewhat	Very Good	
I know how to identify users of an app.	33%	43%	23%	11%	50%	39%	16 pct. points
I know how to create a storyboard and implementation plans for apps.	53%	37%	10%	17%	56%	27%	17 pct. points
I know how to identify a community problem.	23%	43%	33%	0%	28%	72%	39 pct. points
How effectively can you communicate the goals and purpose of apps to others?	30%	47%	23%	6%	61%	33%	10 pct. points
I know how to use the following App Inventor components: button, label, image, horizontal/ vertical arrangement, screens, clock/timer, accelerometer	70%	27%	3%	8%	64%	28%	25 pct. points
I understand the difference between visible and non-visible components.	33%	27%	40%	22%	39%	61%	21 pct. points
I understand how and when to launch the blocks-editor in app inventor.	50%	37%	13%	6%	28%	66%	53 pct. points
I understand when and how to use if/then conditional logic	50%	40%	10%	33%	28%	39%	29 pct. points

Academic Knowledge (cont.)

Communication Technology	PRE			POST			Pre-Post Increase, Pretty Good/Very Good
	Not good at all/Not very good	Neutral	Pretty good/ Very good	Not good at all/Not very good	Neutral	Pretty good/ Very good	
How would you rate your digital publishing skills?	30%	37%	33%	17%	29%	46%	13 pct. points
How would you rate your digital video editing skills?	33%	33%	33%	41%	24%	65%	32 pct. points
How would you rate your audio production skills?	37%	43%	23%	24%	29%	53%	30 pct. points
How would you rate your radio podcasting skills and knowledge?	47%	30%	23%	29%	35%	36%	13 pct. points
How would you rate your digital imaging skills and knowledge?	27%	30%	40%	35%	12%	53%	13 pct. points
How would you rate your skills and knowledge for website design?	33%	33%	33%	35%	18%	47%	14 pct. points
How would you rate your skills and knowledge for video game programming?	27%	13%	60%	35%	0%	65%	5 pct. points
How much do you know about using technology to figure out and fix problems in your community?	20%	40%	40%	24%	12%	64%	24 pct. points
Would you describe yourself as someone who produces media technology (e.g. do you make your own podcast, video games, or music)?	37%	23%	40%	24%	0%	76%	36 pct. points
How confident are you in expressing yourself through technology?	3%	27%	70%	6%	12%	82%	12 pct. points

STEM Attitudes and Aspirations

- **Significant decrease** in the **perception of barriers** students might face in high school in studying STEM (M= -2.3, SD= 4.6, t(23)=-2.3, p=.03)
- **Decrease in endorsement of negative racial stereotypes** about STEM ability from pre- to post-program (M= -.54, SD=1.50, t(23)= -1.8, p=.09), not significant.
- **Increases** in:
  - **Identification** with math and computer science
  - **Aspirations** to take advanced math and science courses in high school
  - Aspirations to **pursue STEM** in college and as a career

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Paired-Samples T-Test Results : Attitudes and Aspirations

Scale	Mean Diff (Pre-Post)	SD	*t*	Sig. (2-tailed)
Attitudes towards Math	.21	1.31	.89	.38
Attitudes towards Computer Science	.43	1.57	1.25	.23
Identification with Math	-.38	1.17	-1.56	.13
Identification with Computer Science	-.24	2.36	-.46	.65
Perceived Barriers to STEM	-2.3	4.60	-2.3	.03**
Racial Stereotypes (STEM)	-.54	1.50	-1.8	.09*
Intending to Take AP Math/Sci in HS	-.33	1.27	-1.28	.21
STEM College and Career Aspirations	-.13	1.31	-.35	.73

*p<.10, **p<.05

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Diverse Networks of Support

- Students reported an **increase** in access to **STEM role models** and access to networks of **diverse STEM peers** (although the increases were not statistically significant).

Scale	Mean Diff (Pre-Post)	SD	*t*	Sig. (2-tailed)
Access to STEM Role Models	-.08	2.36	-.17	.86
Network of STEM Peers	-.64	1.79	-1.67	.11

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Quotes Demonstrating Importance of Diverse Networks of Support

- *"I don't see many Black kids who are in geometry at my school, so I like being around other black students here."*

- *"It made me feel **prouder** about being a Black person because at my school there aren't a lot of African-Americans who are serious about learning and here everyone is African-American and serious about learning."*

- *"My favorite part of the program was being around educated students who **looked like me**."*

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Student Reflections on Program Impact

- *"I got **closer to my goal** of becoming an engineer, through the math I learned."*
- *"[The program] made me feel more interested in learning and **made me want to learn**, because in school the teacher has to control the class and they don't spend as much time teaching"*
- *"I learned **more math here than in school**, and it made me feel less bored."*
- *"It's a better way to learn math, like we are studying for a test at school so we aren't as worried about studying for tests. Here it's **more learning than remembering.**"*
- *"It made me think about how I act because of all the stereotypes. Like Black people won't make it in school. **We are here to prove that we can do well.**"*

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Significance of Findings

- This program for African-American adolescent males impacted critical components for increasing STEM involvement:
  - Academic knowledge in mathematics and technology
  - STEM attitudes and aspirations
  - Perceptions of barriers to STEM
  - Endorsement of negative racial stereotypes
  - Access to diverse role models and networks of support

- This study contributes to literature and policy on STEM equity, and informs strategies for improving STEM outcomes and opportunities for African-American males
- The findings of this study can also contribute to understanding about how to engage other underrepresented groups in STEM.

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Limitations and Future Directions

- This research reports on a small sample size from the pilot year of the program, which limits the generalizability of findings.

- Further research is needed on the specific ways in which each of the intervention components contributes to STEM interest and persistence among African American males in order to contribute to understanding of interventions to increase STEM preparation and outcomes among this population.

- Future research will include:
  - A larger sample of data (the 2013-2014 class has 43 students)
  - Longitudinal data collection, including academic year grades, CST scores, and course-taking patterns
  - Multivariate analyses to control for variables (e.g. FRPL) and examine mediators/moderators
  - Control group of similar African American male students and their progressions through middle school

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