"I Think We Were Pretty Powerful This Summer as Scientists": Generating New Possibilities for Youth of Color in Science

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Abstract. This research explores processes of learning and identity construction for high school students of color as they engage in a community-based scientific research project as part of a summer science program. This research utilizes qualitative (e.g. interviews) and quantitative (e.g. surveys) data sources. Findings illustrate the emergence of an identity generative process: that engaging in science practices (e.g. presenting research) and the accompanying program resources (e.g. placing students in a position of power) generated new possibilities for students as capable science learners, scientists, and change agents. Furthermore, findings show that the instructor's perspective of science and vision for his students guided the design of program resources (e.g. pedagogy, instruction) made available that helped create these shifts. Findings show that youth of color can imagine new possibilities for who they can be in science if their science and racial identities are supported in science programs.

Keywords: identity, science practices, youth of color, community-based research, instructor vision

Introduction

The underrepresentation of high school students of color in advanced science courses and the need to increase diversity in science fields is widely agreed upon (Oakes, Ormseth, Bell & Camp 1990; Darling-Hammond, 2010). In addition, developing the next generation of innovators in science, technology, engineering, and math (STEM) is deemed essential because it is linked to the nation's economic prosperity (National Research Council, 2011). This highlights two issues: a need to increase diversity and foster innovation in science fields.

The challenge of increasing racial/ethnic diversity in science is complicated by two dominant representations: 1) *what* science is (i.e. what gets counted as science practices), and 2) *who* does/can do science. These representations too often provide narrow images of science (e.g. prescribed labs) and scientists (e.g. white, male) that are problematic for youth of color who don't see themselves within the bounds of these narrowly defined categories. A typical solution to increasing diversity is to focus on reframing *what* science is through curricular and policy reforms (e.g. National Research Council, 2011). While this is an important part of the solution, race-based achievements gaps are persistent (National Science Board, 2012). This pushes us to consider how we think about equity; as not only access to authentic science experiences but also opportunities to see oneself as a capable science learner. I argue that in order to make progress towards increasing diversity in the sciences, we need to extend beyond a focus on *what* science is and pay equal attention to the messages youth of color receive about *who* they can become in science based on the resources made available in science learning environments.

Objective

This research takes a holistic approach to understanding processes of learning and identity construction for high school students of color as they engage in a community-based scientific research project as part of a summer science program. I explore how the possibilities high school students of color view as available to them in science are reimagined and transformed through program participation. The goal of this research is to better understand the mechanisms that support the generation of new possibilities: how engaging in science practices and the programs resources made available for the practices (e.g. instruction, pedagogy, designed experiences) generates new possibilities for *who* youth of color can become in science. To do this, I explore how the science instructor's perspective of science (e.g. purpose, utility) and his students (e.g. social positioning) and the vision he has for how students can use science in their lives guided the design of the program resources made available while engaging youth in scientific research. In addition, I document the shifts that occur for students and how the program resources made available support holistic identity construction (i.e. students' science and racial identities) and allow students' agency and power to come to life.

The aspirational thinking expressed by two scholars encompasses what it means for educators to have a vision specifically in relation to working with youth of color from historically marginalized populations. In an interview broadcast on a local radio program, Dr. Cornel West encouraged teachers from schools serving predominantly youth of color to develop opportunities for their students to become creators. In this way, students are empowered as agents who are able to create change in their lives. Along similar lines, during a presentation to undergraduates at the University of California Berkeley, Dr. Kris Gutierrez encouraged aspiring educators to

approach learning with new social and pedagogical imaginations, to promote what is possible, and to provide tools for youth of color to become social dreamers and designers of their own futures (Gutierrez, 2008). Both of these scholars speak of providing tools that allow students to hope, dream, design and create change. This research builds on this visionary thinking to illustrate what is possible in a science program when there are opportunities to generate hope and possibility and when an instructor's vision shapes program resources that position students as doers of science and agents of change in their community. I ask three main questions:

- What shifts for high school students of color in regards to how they see themselves in relation to science following program participation? What are the mechanisms involved?
- How do instructors' perspectives of science (e.g. purpose, utility) and their students (e.g. social positioning) guide the design of program resources (i.e. instruction, pedagogy and designed experiences) made available while engaging youth in scientific research?
- What types of program resources support the co-development of students' science and racial identities and generate new possibilities for *who* they can become in science?

Theoretical framework

This research draws on sociocultural theories of learning and identity (Wenger, 1998). I view identities as fluid, dynamic and socially constructed from the resources available (Holland et al., 1998) as students are positioned in science learning environments (Harre, 2008). This research views learning as not only taking on new knowledge structures but guiding personal transformations of "becoming" (Nasir & Hand, 2006). I define *identity* as how youth of color perceive science, how they see themselves in relation to science, and how the interactions they have and believe they can have shape *who* they become in science. This involves their ideas about *who* does/can do science and their ideas about *what* scientist do.

Scholars examining learning and identity construction provide important insights into the types of identities offered and authored by youth of color in science learning environments across formal and informal contexts (e.g. Aschbacher et al., 2010; Calabrese Barton, Tan & Rivet, 2008; Polman & Miller, 2010). In addition, research shows how engaging youth in science practices and scientific investigations supports processes of learning and identity construction and provides unique opportunities for students to: develop deep understanding of content (Lehrer, 2009), construct unique epistemological stances (Sandoval, 2005), perceive themselves as real scientists and identify as capable learners (e.g. Bowen & Roth, 2007). As one type of investigation, research shows that community-based research can empower youth as change agents (e.g. Bouillion & Gomez, 2001). I define *science practices* as types of activities utilized to conduct scientific research and/or produce scientific knowledge through the research process.

While research shows that racial positioning matters for the long-term trajectories of women of color in science (Carlone & Johnson, 2007; Johnson et al, 2011, Malone & Barabino, 2008), treatments of race in relation to science are limited (Parsons, 2014). More research is needed that examines intersections of students' racial and disciplinary identities (Varelas, Martin, Kane, 2012). In addition, research is needed that offers insights into how students' science and racial identities *develop* together through participation in science practices.

Conceptualizing program resources

This research explores how the types of program resources made available in science learning environments supports youth of colors' practice-linked identities in science (i.e. viewing participation in a practice as central to who one is) (Nasir & Cooks, 2009; Nasir 2012). I define *program resources* as the types of instruction, pedagogy and designed experiences that instructors make available to students in science learning environments as they engage in science practices. I utilize the "practice-linked identity" framework and its supporting identity constructing resources (Nasir & Cooks, 2009; Nasir, 2012) in order to explore how learning, positioning and engagement in science develop together in context as students participate in the summer science research program.

Conceptualizing pedagogical vision

As one source of power in science classrooms, teachers have the ability to offer alternative possibilities and roles for their students through the organization of institutional structures, cultural practices, social interactions, and relationships (Nasir, 2004). This research explores how an instructor's "pedagogical vision" guides the organization and structuring of activities in a science program in ways that empower youth of color as doers of science and agents of change in their community. I define *"pedagogical vision"* as the ways that teachers' own backgrounds and experiences inform their goals and purposes for teaching science, what they envision their students doing with science, and the possibilities they create for *who* their students can become in science. The conceptualization of a "pedagogical vision" builds from Cole's (1996) idea of ideal artifacts and the process of

"prolepsis". Cole (1996) conceptualizes ideal artifacts as ideas, experiences and cultural pasts that shape our imagining of what is possible in the future. These artifacts carry meaning across time through prolepsis (Cole, 1996). Through the process of prolepsis ideal artifacts from cultural pasts are projected into the future in ways that structure and mediate activities at present (Cole, 1996). Bringing the idea of prolepsis to schooling, Nasir (2004) describes how educator's cultural pasts, experiences, and world views (i.e. ideal artifacts) shape the futures they imagine for their students and the organization of school practices at present (e.g. norms, activities). Of particular importance is that ideal artifacts align with actions to influence the structuring of the classroom environment and interactions between teachers and students in the present (Nasir, 2004). The type of vision, I explore in this study centers race, is historically embedded, and politically and racially conscious.

Methods

This research employs qualitative (e.g. interviews) and quantitative (e.g. surveys) data sources with students as the unit of analysis. I utilize a multiple case sampling approach (Miles & Huberman, 1994) with variability on student's incoming identity and perceived ability in science to capture a range of student experiences.

Program

The Westport summer science program engaged youth from underserved communities in community-based scientific research. Participants attended the program for four hours per day, five days per week for a total of seven weeks during the summer. During program participation, students conducted a seven-week long air quality research project involving a local transportation agency. Students participated in and contributed to all aspects of the research process including: the generation of overarching research questions, experimental design, and data analysis.

Participants

Students in the program attended grades 9-12 from Northern California schools. All student participants (n=11) identified racially as youth of color; the majority identified as Latino. Students entered the Westport program with low average perceived ability in science scores based on pre program surveys and commonly described experiencing little success in science class in school. The majority of the students participated in the summer program because they had failed science class or needed to make up science credits though some students voluntarily participated.

The lead instructor for the Westport summer science research program, "Matt", graduated with an environmental science degree and had a strong disciplinary and science research background. He identified racially as white. He had been working as an instructor for the summer program and was a veteran at guiding students from underserved communities in the design and implementation of community-based research.

Data sources and analysis

This study utilized four data sources: 1) Pre and post program student surveys, 2) Pre and post program focal students interviews, 3) instructor interview, and 4) program observations.

Pre and post program student surveys

9 of the 11 students in the Westport program completed pre and post program surveys. The goal of pre and post program surveys was to establish a baseline (pre) and determine changes (post) in students' attitudes towards, ideas about, and perceptions of ability in science as well their ideas about the scientific research process. Pre program surveys were administered on the first day of the program; post program surveys on the last day of the program.

Survey Analysis. Attitudinal questions appeared as Likert scale items on pre and post program surveys. Likert scale items were scored from 1-5 with 5 representing the most positive response and 1 representing the most negative response. All items for a validated scale were considered a subcategory (e.g. science identity). To determine differences between students, data was averaged by subcategory for individual students.

Interviews

All interviews were semi-structured and audio recorded. *Focal students*. Seven focal students completed pre and post program interviews. Interviews lasted ~45 minutes. Pre program interviews were designed to capture students' ideas about science practices, who does/can do science, how students saw themselves in relation to science and other aspects of their science and racial identities. Post program interviews asked students to describe their research projects, what they did to conduct scientific research, and about shifts in identity.

Scientist Instructor. The lead instructor completed an interview following completion of the program. The interview lasted ~45 minutes. Interview questions captured: goals for instruction, utility of scientific research, science practices promoted and sense making about racial disparities in the professional science community. Interviews also captured instructors' ideas about their students that included: racial backgrounds, societal positioning and experiences engaging youth in scientific research.

Interview Analysis. Focal Students. Transcripts were coded through an iterative process for ideas about science practices and identity that included: engagement in science practices, uses for scientific research, and aspects of science/racial identity. All coding categories emerged from the data and were not predetermined. In some cases direct links could be made between science practices (e.g. collecting data) and identity statements (e.g. I am good at science). When a science practice could be directly linked to an identity statement (e.g. collecting data made me feel good at science), this was coded together as an identity/practice statement. Practice/identity statements were analyzed as a unit to determine how engaging in science practices "functioned" for students with regards to identity construction. *Scientist Instructor*. Transcripts were read and coded for perspectives of science and students and goals for instruction. Together with program observations, interviews were used to determine how an instructor's "pedagogical vision" shaped the program resources they made available.

Program observations

Program observations were made two to three times per week for the duration of the program. Field notes were recorded and were used to capture the mechanisms associated with program participation and the types, availability and uptake of resources in real-time. Program observations were designed to capture moments of positioning between participants and instructors and the types of resources made available and exchanged between participants (e.g. students, instructors) during the programs.

Observation Analysis. Field note coding was done inductively and through an iterative process to remain open to novel constructs, interactions, and resources (Miles & Huberman, 1994). Field notes were coded for types of program resources made available (e.g. instruction), how the resources were taken up and utilized or resisted by participants and moments of positioning between students and instructors.

Findings

Findings show that students' ideas about *what* science is (e.g. science practices) and who can do science shifted together while engaging in scientific research. Participation in community-based research: 1) allowed students to add new types of science practices to their repertories, and 2) broadened the meanings students' associated with science practices from restrictive (e.g. prescribed, right/wrong) to expansive (e.g. science as iterative process). Developing expansive meanings promoted learning, allowed students to make connection between practices, helped make science more accessible and allowed students to identify as capable science learners. In addition, almost all Westport students identified themselves and their peers as scientists following program participation. Furthermore some Westport students specifically identified youth of color as scientists following program participation.

Findings show that Westport students made gains in perceived ability (e.g. how they saw themselves as science learners) and identified themselves and their peers as scientists because of what they were able to *do* as scientists. For example, different aspects of the data collection process created new ways to engage with science, made science accessible and cultivated the identity of a capable science doer and learner. In addition, engaging in multiple aspects of the research process generated new meanings for science practices and uses for scientific research that elevated the power and agency associated with the identities generated. In addition, findings show how the opportunity to construct new knowledge about their community (i.e. collect/analyze data) and to share this information with people in positions of power (i.e. present research) broadened students' ideas about the utility of scientific research, *where* research can be done, and *who* it can impact.

To illustrate these findings, I (briefly) present a case study of a focal science practice: *presenting research*. I examine relationships between: 1) the program resources (i.e. instruction, pedagogy, designed experiences) made available for the science practices, 2) the nature of the shifts that occurred for students while engaging in these practices and accompanying resources, and 3) the types of identities that were constructed through this process.

Case example: Presenting research

Westport students collected air quality data involving a local transportation agency over the course of the summer. As a culminating presentation, Matt arranged the opportunity for students to present their research to administrators from the transportation agency. The experience of presenting research in a high stakes context

empowered the students and generated a new possibility for *who* they could become in science: *change agents* in their community.

Program resources: Vision and positioning as change agents

Matt had a particular perspective of science and of his students, as youth of color from an underserved community, that informed his programmatic goals and the design of instruction, pedagogy, and experiences he made available. His years of experience working with underserved youth shaped his perspective of his students and his ideas about his role as a science instructor. He describes his perspective:

> Science helps reveal the relationship a lot of young people and their families have with the larger system that has alienated them so much from power or having any sort of dignity.

His perspective merges ideas about hierarchical power structures in society, science and the positioning of his students. He views his students and their families as lacking power and science as a tool that can make this transparent. As described above, many of the Westport students were in the summer program because they had failed their science class in school. Matt builds on his idea about how his students are positioned: "So many of the students that we work with have extremely low self-efficacy, self-esteem and a lot of that stems just from their social and class position in society." Here, Matt makes connections between this lack of power, societal positioning of his students, and their social-emotional well-being. Instead of seeing his students as failing, he sees them as youth who need social-emotional support and encouragement.

Matt's goal was to create an opportunity for students to see that the air quality data they collected could lead to change and to disrupt the lack of power he felt that they experienced in their daily lives. He describes his perspective of science:

> My larger goal is to have them be able to be scientist in all aspects of their lives, whatever they end of up doing. So that they can have a critical lens on the world and so they're not just, assuming everything is just the ways it is, but they can use science to create change in their lives and communities.

Matt views science as a tool that his students can use to create change in their lives. To support this and his goal to empower his students as change agents, Matt designed an experience that specifically placed his students in a position of power: presenting their research to representatives from the transportation agency where students had collected their data. Matt described his vision for the research presentations that guided the resources he made available for this practice: "They (the students) have to see that all the data collection and analysis that they've done, actually leads to…some sort of changes." Collecting and analyzing data provided an opportunity for students to construct new knowledge relevant to their community and presenting their findings provided a platform to share this new knowledge in an empowering way. Throughout this process, Matt positioned his students as agents of change and provided opportunities that created the potential for this to become a reality.

What shifts for students? Generating identities as change agents

The experience of presenting research functioned in two main ways that allowed students to see themselves as agents of change in their community. First, the experience of communicating their findings through research presentations gave new meaning to this practice and shifted students' ideas about uses for scientific research. Second, power shifted to the students, as youth of color, as scientists.

Becoming change agents: Broadening ideas about uses for scientific research

Presenting research broadened students' ideas about the meaning of science practices. During his post program interview, when asked what he learned about the scientific research process, Fernando, a 12th grade student who identified racially as Latino describes his ideas:

> Science is not just like...finding out facts. You actually need to know how to present what you are going to do, like to be able to get your data or whatever you researched out to people, you gotta talk to people, like look this is what my project was, this is what I found out, so the majority of it was finding the data. But the other part was like actually knowing how to present it out.

Fernando describes a shift in the meaning he associates with science practices from restrictive and static (i.e. finding facts) to expansive and active (e.g. collect data, present research). He also made a connection between the practices of collecting data and presenting. In this way, the purpose of collecting data was generated through the context of presenting research (i.e. "get data out to people"). In addition, Fernando's statement indicates a shift in

agency. When he says, “look this is what my project was, this is what I found out”, he asserts that he has something to tell people and that their research is important.

In addition, students’ ideas about uses for and the importance of scientific research shifted because of their experience presenting in a high stakes context. Collecting data in their community and presenting their research findings broadened students’ ideas about *where* scientific research can be done and *who* it can impact. Natasha, a 12th grade student who identifies racially as Chicana provides an example. She described the importance of their air quality research they conducted: “Nobody’s…doing stuff out here, like in low-income communities to make the air better. I guess that's why we're doing the research.” Natasha places a particular importance on *where* she and her peers are collecting air quality data. In addition, Cid, a 12th grade student who identifies racially as Latino makes a similar connection. On a post program survey he stated that his ideas about uses for science were “completely different now” after presenting their air quality research. He explained why his ideas shifted so dramatically: “Because the data can actually be used to change people's mind.” In addition, he stated on the survey that their research was “very important” and when asked to explain to whom he stated: “to people in our community, Black and Brown.” Cid makes an important connection between data and the impact data and research findings can have on people when shared publicly, especially to people n positions of power. As Fernando described above, the students learned that presenting was a way to get their research out to people. Here, Cid describes the impact this information can have to “change people’s minds”. Fernando, Natasha and Cid suggest that their research is important to people in their community and that their findings can be used to create change. In this way, the identity of change agent was constructed.

Shifting power to youth of color

Students expressed a significant transformation and shift in power that occurred over the course of the summer. For example, when Melanie, a 10th grade student who identified racially as Filipina entered the program she described scientists as people who were high status and not from her racial background:

> I've never heard of a professional Filipino scientist. Maybe it's just a lot of the other races don't feel comfortable. Here, it's a lot of low-income or working class people and they probably don't feel like they're good enough to become a scientist, cause it's like high.

She describes not knowing any Filipina scientists and reasons that people from certain races and classes might not be “comfortable” or feel that they can achieve the high status of a scientist because of their societal positioning. She also described scientists as “powerful” and when I asked her why she stated: “Because they are labeled scientist, and that makes them smarter than everyone else.” In this way, Melanie describes the power she associates with the position of scientist and how this power is linked to knowledge.

> After participation in the summer program, Melanie still views scientists as powerful. She explains: I think scientist are pretty powerful. I think we were pretty powerful this summer as scientist and through out the year it paid off because we got to present in front of these representatives and I think that was powerful for us to do.

Here, Melanie describes a shift in power: who is a scientist has shifted from people that are “not her race” to herself and her peers as powerful scientists. In addition, she expresses a shift in power to herself and her peers because of what they were able to do as scientists (i.e. present to the representatives). In addition, she describes the importance of working together as a community of youth of color:

> I think its really important to represent and show people that scientists aren't powerful because of their race, but because of who they are and what they want to accomplish as a scientist and what they want to contribute to their community so I feel like its really important for people of color to represent scientist.

Presenting their research in a high stakes context provided an opportunity for Melanie and her peers to disrupt historically embedded power structures. Melanie was able to construct a new image of *who* can occupy the powerful position of scientist that included herself and her peers. Together the students experience generated a new possibility; that of becoming *scientists* and *change agents* in their community.

Findings illustrate how the opportunity to construct new knowledge about their community and to share this information with people in positions of power broadened Westport students’ ideas about the utility of scientific research, where research can be done, and *who* it can impact. Matt’s goals were to create an opportunity for students to see that the data they collected could lead to change and to disrupt the lack of power he felt that they experienced in their daily lives. The opportunity to present their research in a high stakes context made these

goals a reality. Engaging in the science practice of presenting research shifted the purposes and uses for scientific research, generated new possibilities for *who* students could becomes in science, and shifted power to youth of color.

Conclusions and implications

Findings illustrate the emergence of an *identity generative process*: that engaging in science practices (e.g. presenting research) and the accompanying program resources generated new possibilities for Westport students as *capable science learners*, *scientists*, and *change agents*. Findings show that the instructional and pedagogical resources made available for science practices determined *how* the practices "functioned" for students. In this way, the generation of new possibilities for focal students was program resource dependent. Furthermore, findings show that the Westport instructor's vision of science (e.g. purpose, utility) and his students (e.g. racial background, social positioning) guided the design of the program resources he made available. Because he viewed his students as lacking power and having low self-efficacy due to their race/class positioning in society and he viewed science as a tool to create change, he made unique resources available for particular science practices (e.g. collecting data) that empowered students as change agents in their community. Findings show that youth of color can imagine and take up new possibilities for who they can be in science when their identities are holistically supported in science programs.

This research illuminates mechanisms that support the generation of new possibilities for youth of color in science. Exploring this identity generative process as a unit of analysis highlights that simultaneously expanding students' ideas about *what* science is and *who* can do science generates new opportunities for youth of color in science. In addition, this research extends our understanding of the significance of an instructor's "pedagogical vision" in guiding the design of program resources (i.e. pedagogy, instruction, designed experiences) that support holistic identity construction.

Scholarly significance

Findings inform the design of learning environments that create multiple pathways for learning and identity construction in science. In addition, findings can be leveraged across contexts to construct educational resources that support meaningful learning opportunities in schools. As states adopt the Next Generation Science Standards (NGSS, 2013), a unique opportunity exists to develop educational resources that engage students in science practices and support identity construction for youth of color in holistic ways. Findings can be applied to the creation of opportunities in science programs, classrooms, and teacher education that foster successful and meaningful engagement with science practices and empower youth of color as capable learners, doers and changes agents in science. In this way, we can truly create space for youth of color in science learning environments and broaden opportunities for participation in science.

References

Aschbacher, P.A.,Ellen, E.L., Roth, J.(2010).Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research Science Teaching*, 47(5), 564-582.

Bouillion,L.M & Gomez, L.M. (2001). Connecting School and Community with Science Learning: Real World Problems and School-Community Partnerships. *Journal of Research in Science Teaching,* 38(8), 878-898.

Bowen, G.M. & Roth, W.M. (2007). The practice of field ecology: Insights for science education. *Research in Science Education,* 37, 171-187.

Calabrese Barton, A., Tan, E., & Rivet, A. (2008). Creating hybrid spaces for engaging school science among urban middle school girls. *American Educational Research Journal*, 45,68–103.

Carlone, H.B. & Johnson, A. (2007). Understanding the science experiences of successful women of color:Science identity as an analytic lens. Journal of Research in Science Teaching, 44(8)1187-1218.

Cole, M. (1996). Cultural psychology: A once and future discipline. Cambridge, MA: Belknap Press of Harvard University Press.

Darling-Hammond, L. (2010) The flat world and education: How America's commitment to equity will determine our future. New York: Economic Policy Institute and Teachers College Press.

Gutierrez, K. (2008). Developing a sociocritical literacy in the third space. *Reading Research Quarterly*, 43, 148-164.

Harre, R. (2008). Positioning Theory. Self-Care and Dependent-Care Nursing, 16(1), 28-32.

Holland, D., Skinner, D., Lachicotte, W., and Cain, C. (1998). Identity and Agency in Cultural Worlds. First Harvard University Press.

Johnson, A., Brown, J., Carlone, H., and A.K. Cuevas. (2011). Authoring identity amidst the treacherous terrain of science: A multiracial feminist examination of the journeys of three women of color in science. *Journal of Research in Science Teaching*, 48(4), 339-366.

Lehrer, R. (2009). Designing to develop disciplinary dispositions: Modeling natural systems. *American Psychologist*, 64(8), 759-771

Malone, K.R., & Barabino, G. (2008). Narrations of race in STEM research settings: Identity formation and its discontents. *Science Education*, 93(3), 485-510.

Miles, M. B. & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook. Second edition. Thousand Oaks: Sage.

Nasir, N.S. (2004). "Halal-ing" the child: Reframing identities of resistance in an urban Muslim school. *Harvard Education Review*, 74(2), 153-174.

Nasir, N.S. (2012). Racialized Identities: Race and Achievement Among African American Youth. Stanford University Press, Stanford, CA.

Nasir, N.S. & Cooks, J. (2009). Becoming a hurdler: How learning settings afford identities. *Anthropology & Education Quarterly*, 40(1), 41-61.

Nasir, N.S. & Hand, V. (2006). Exploring sociocultural perspectives on race, culture, and learning. *Review of Educational Research* 76(4), 449-475.

National Science Board (2012). Science and Engineering Indicators Digest 2012. Arlington VA: National Science Foundation (NSB 12-02).

National Research Council. (2011). Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics.Washington, DC: National Academies Press.

Oakes, J., Ormseth, Bell & Camp (1990). Multiplying inequalities: The effects of race, social class, and tracking on opportunities to learn mathematics and science. RAND Report. Pp. 1-152.

Parsons, E. C. (2014). Unpacking and critically synthesizing the literature on race and ethnicity in science education. In N.G. Lederman & S.K. Abell (Eds.), Handbook of research on science teaching, volume II (167-186). New York: Routledge.

Poleman, J.L. & Miller, D. (2010). Changing stories: Trajectories of identification Among African American youth in a science outreach apprenticeship. *American Educational Research Journal*, 47, 879-918.

Sandoval, W. A. (2005). Understanding students' practical epistemologies and their influence on learning through inquiry. *Science Education*, 89, 634-656.

Verelas, M., Martin, D.B, Kane J.M. (2012). Content learning and identity construction: A framework to strengthen African American students' mathematical and science learning in urban elementary schools. *Human Development* 55, 319-339.

Wenger, E. (1998). Communities of practice: Learning, meaning, and identity. New York: Cambridge University Press.