

Impacts of Peer Mentorship in a Calculus Workshop on the Mentors' Identities and Academic Experiences in Undergraduate STEM

Aditya P. Adiredja
The University of Arizona

Luis Leyva
Vanderbilt University

Jorge Mendoza
The University of Arizona

Research has shown the positive impact of peer mentorship on the educational experiences of mentored students from underrepresented backgrounds. National survey data of peer leaders indicate that peer mentors also benefit from the mentoring experience. This report unpacks this survey finding related to peer mentors' increase in a sense of belonging in college and academic persistence as a result of participating in the mentorship. Our data draws from interviews with six historically marginalized students of color after their participation as mentors for a group of first-year calculus students during a summer bridge calculus workshop. The mentors' main responsibility was facilitating critical conversations about racial and gender in Science, Technology, Engineering, and Mathematics (STEM). Preliminary analyses found that mentoring contributed to their confidence in succeeding in a STEM field and their ability to make sense of gendered and racialized educational experiences in STEM.

Keywords: equity, identity, peer mentors, STEM

Research has documented the benefits of mentorship in facilitating persistence of students of color in Science, Technology, Engineering, and Mathematics (STEM; Griffin et al., 2010). Some research has shown that, second to faculty mentoring, peer involvement is the strongest predictor of African American and Hispanic students' academic performance and educational satisfaction (Cole, 2008). Some qualitative studies have also documented the desire for many successful students of color in STEM to give back and be role models in their communities (e.g., Ellington & Frederick, 2010; McGee & Martin, 2011). Peer mentors can be defined as, "students who have been selected and trained to offer educational services to their peers [that] are intentionally designed to assist in the adjustment, satisfaction, and persistence of students toward attainment of their educational goals" (Ender & Kay, 2001, p.1 as cited in Shook & Keup, 2012). Benefits of peer mentorship on students being mentored documented in the literature include: the development of communities and relationships with students of similar identities, and the sharing of resources among students (Shook & Keup, 2012). Higher education research has also explored the benefits of peer mentorship on the institution (e.g., cost-effective student support). For this paper, we focus on the benefits of peer mentorship on the mentors themselves.

The National Peer Leadership Survey by the National Resource Center for The First-Year Experience and Students in Transition in 2009 found that, among the nearly two thousand students in peer leadership programs in different institutions, 81 percent of them said that their experience increased feeling of belonging at the institution. Seventy-one percent indicated an increase in their desire to persist academically (Shook & Keup, 2012). This paper aims to unpack those findings from the survey. In particular, we want to explore possible mechanisms behind the increase in sense of belonging and desire to persist in the discipline. Thus, in this report, we focus on the following research question: How does participating in a peer mentorship program about race and gender in STEM impact the mentors' STEM identities and participation?

Theoretical Frameworks

This paper employs a sociopolitical perspective, which focuses on investigating some of the accepted norms and practices within the field of mathematics that privilege some people while excluding others (Gutiérrez, 2013; Valero, 2004). Gutiérrez (2013) explains that adopting a sociopolitical perspective involves considering the interrelatedness of knowledge, power, identity, and social discourse. This is to say that power and positioning as a result of existing narratives about groups of students impact the way they see themselves as learners and how they learn. Past research in mathematics education has illustrated how students' identity constructions shape participation and vice versa in mathematics learning specifically (Boaler & Greeno, 2002; Esmonde, Brodie, Dookie, & Takeuchi, 2009; Cobb, Gresalfi, & Hodge, 2006; Langer-Osuna, 2011; Martin, 2000; Oppland-Cordell, 2014). We build on these insights to explore the connections between identities and participation in STEM and the more informal learning context of peer mentoring.

Martin (2000) presented a multi-level framework on sociohistorical, community, school, and intrapersonal influences on African American students' racialized opportunities for mathematical participation and co-constructions of mathematics and social identities. Martin (2000) defined *mathematics identity* as individuals' beliefs about "their ability to perform in mathematical contexts, the instrumental importance of mathematical knowledge, constraints and opportunities in mathematical contexts, and the resulting motivations and strategies used to obtain mathematics knowledge" (p. 21). Our analysis is framed by an extension of Martin's (2000) framework and definition to allow for consideration of how other social identities (e.g., gender) intersect with race to shape peer mentors' identities and participation in STEM.

Methods

Context

The Calculus summer workshop was originally designed to increase the representation of underrepresented minority students in the mathematics major. The five-day summer calculus workshop prepares students for their first calculus course in college, highlights productive study skills, and builds a peer support network. Students also receive individual academic advising. As part of the workshop, students engaged in five critical conversations about race, gender, and STEM. The curriculum for the conversations was designed in collaboration with the Dean of Students on Diversity and Inclusion. Two conversations were held during the five-day workshop, two in the fall semester, and the final session in the early spring semester. The conversations served two goals. First, they aimed to empower students with language and tools to make sense of and navigate racialized and gendered experiences they might encounter in being a STEM major (McGee & Stovall, 2015). Second, the conversations were opportunities for students to check in about their first semester in college and their calculus course. Topics for the conversations included students' hopes and fears about their first semester, the importance of a STEM network, and stereotype threat and management.

Data Source

This study is part of a larger study investigating the impact of the summer workshop and critical conversations on participants' personal and academic success. Eight peer mentors received training in facilitating conversations about race and gender in STEM. We recruited these students from different cultural centers on campus. Their training mainly involved engaging students in activities that their mentees would complete. They also received some

training on opening and facilitating discussions. Six of the eight peer mentors for the workshop participated in an individual 60-90 minute exit interview at the end of their participation. Their background information is provided in Table 1. In addition, as part of their training for the 2017 workshop, they briefly reflected as a group on their experiences as a peer mentor in the 2016 workshop.

Table 1. Peer Mentors Personal and Academic Background

<u>Student</u>	<u>Racial/Ethnic Background</u>	<u>Academic Major</u>	<u>Grade Level</u>
Fernando	Hispanic/Latinx	Physiology ^a	Sophomore
Hamza	African American/ Black	Physiology	Junior
Hugo	Hispanic/Latinx	Biochemistry & Molecular and Cell Biology	Senior
Lorena	Hispanic/Latinx	Physiology	Sophomore
Sarah	Hispanic/Latinx	Biochemistry	Sophomore
Sabrina	Hispanic/Latinx & White (Non-Hispanic)	Physiology	Junior

^aMost students planning to attend medical school major in Physiology

We were able to observe impacts of their participation as students reflected on their own STEM learning experiences and related them to their social identities. We looked for statements where there was a clear attribution of a change in behavior to participation in the peer mentorship program. We transcribed all of the interviews. The first author of this report is the interviewer in the study.

Analysis

We specifically focus on the impacts of the peer mentorship on the way students perceived their experiences and participation in the STEM field. Some themes emerged from our analysis. The critical conversations that these students facilitated focused on empowering students with language and tools to make sense of and navigate any racialized and gendered experiences. Most of the themes that emerged related to students' identities and sense-making of their own racialized and gendered STEM experiences.

One of the documented benefits of peer mentorship for mentored students was that it provided them opportunities to connect with mentors who shared similar social identities. We found that the peer mentors experienced similar benefit. Hamza spoke about the impact of the peer mentorship and critical conversations on him as a Somali-American:

It was impactful because it was the first type of conversation I was able to have on campus here at the University. It was special for me. Myself, I am going through social identities and finding out who I am /.../ I don't get to have conversations with other immigrants because of distinct language barrier. I didn't grow up knowing Somali. Me and like all the other refugees that came, there is that distinct separation. When my parents came in the 1970s and other families came in 2002 and 2001. So I, there is a very big disconnect between that point and I was able to have the discussion, yeah this is what it's like. I really liked having our conversation.

There happened to be two Somali students in the workshop that summer, and it provided Hamza with a particularly powerful experience. Lorena shared a similar experience of resonating with a

Hispanic mentee's feelings of isolation on September 16th, Mexican Independence Day. The mentee shared with Lorena that he noticed that no one in class knew the significance of that day.

Five of the six students mentioned at least one specific racialized and gendered experience that they identified after participating in the program. Sabrina shared her awareness of being the only woman of color in her research lab. In her reflection, she spoke about how the training she received as part of this program helped her make sense of this experience and allowed her to learn from and relate to another peer mentor.

Sabrina: Especially in a lab or something and I think I have thought about it more because of this peer mentor stuff because the first time I walked in there I was like oh this is what doctor Adi and everyone was talking about. This is weird [*laughs*]. So I have never had an experience like that. So that was just so weird on the very first day.

Interviewer: So we had a conversation like this? Was before the training or was it during the training?

Sabrina: Yeah. It was during the training. I don't remember who it is, but someone was saying, it might have been Hamza, how he was saying how he was the only Black person in a sea of White people. I think it was one of his classes. I never actually had to deal with being the only person of some sort in a sea of different people. That was the first instance where I was the only person. So I understood how he felt on the gender spectrum of it. I feel like that's something he has to deal with all the time especially here at [the university]. So, I was thinking about that couple days ago. I hope he doesn't always feel like this and coping with it and dealing with it one way or another because this is a terrible feeling. It's not a good one.

Interviewer: It really isn't. How has this experience helped you with your experience? The first time you recognized it but do you do anything about it. Do you do anything different?

Sabrina: I almost do it where we're in the lab meetings and almost intently make sure that everyone knows I'm listening like I'm nodding my head like, oh yeah. So it's almost like I want them know that I'm engaged in what they're saying and not just some undergrad who is there to not just get credit or just working in a lab, because I don't want that perception to go back on me.

McGee and Martin (2011) have shared similar accounts from other students of color in managing stereotypes by staying on top of things, sitting in front of the class, and appearing engaged. What is powerful about Sabrina's learning is that her awareness led to this change in behavior, but it also allowed her to empathize with other students' experiences at the university.

Lorena provides another example of a mentor making sense of a racialized STEM experience. Initially in her reflection she could not articulate what bothered her about seeing students who did not put in as much effort into their education continuing to be in her program. The interview was the first time she made sense of it. After recalling a conversation she had while walking to class with some students, she came to this conclusion:

You know, my parents did not go to college. I'm totally here because of me. It's 100% me because I'm very smart and all these things. It is true and I don't know if it's a bad thing or it is, I'm saying true things. These people, it's not a bad thing that their parents are educated. I hope to be a very educated parent living financially stable and comfortable. But does the way that they [*pause*]. See, I'm talking about they. You know certain types of groups [*pause*]. You know like I'm just so thankful and that I can do all of this. To them it's like, "Oh. All I need to get is like a D so that my dad can keep paying

for college." It's like you're paying 12,000 dollars so that you can go to fun parties. And that's kind of my stereotype to that group of people. It's like you're doing all of that and I'm doing all this and we're still on the same track.

In this quote, Lorena not only positioned herself as a smart and resourceful student, but she also challenged the lack of consequence to the more privileged students who did not work as hard as her. This brings us to the next pattern we observed in our data: a change in self-perception and perspective as STEM students.

During their group reflection, Fernando spoke about an increase in confidence in being a STEM student as a result of his ability to give advice on the spot to the students.

Fernando: You've been through enough and you've done well enough. You can provide that information to help other students succeed. It gives you confidence.

Interviewer: Others feel free to chime in. Do you realize you're successful *after* you give the advice, or before you give the advice? Or the act of giving advice, "Oh I didn't know I could do that!"

Fernando: I'd say during.

Lorena: Yeah.

Fernando: They asked you a question. And it's not like you prepared for these questions.

And they asked you. And you're like oh [*everyone laughs*].

Interviewer: Lorena is patting herself on the back.

Fernando and Lorena shared this increase in confidence as a STEM student. Hugo provided a different impact on his participation. He shared that, leading up to the peer mentorship, he had felt worn out by his class work. Interacting with students in the mentorship program gave him "more positive energy" to finish his studies.

Discussion and Implications

The aim of this report is to unpack some of the findings from the National Peer Leadership Survey (2009). In particular, we were interested in understanding the impact of a peer mentorship program on the peer mentors' identities and participation in STEM. We found that the program impacted the peer mentors by: 1) providing them opportunities to connect with other students who shared their social identities; 2) helping them recognize and make sense of their own racialized and gendered experiences as STEM students; 3) giving them a new perspective and confidence as STEM students. We note that Fernando, Hamza, and Hugo were inspired and acquired other leadership positions on campus as a result of their participation in this program.

This report has implications on the learning and teaching of undergraduate mathematics. The aim of these conversations is to provide both the peer mentors and the calculus students a space to process racialized and gendered experiences in their STEM education. The calculus workshop and the critical conversations serve as academic and social forms of support in students' STEM educational experiences. How can we intentionally and systematically link these initiatives with calculus courses across mathematics programs? How might we extend this work to the training of graduate students as future instructors? We hope to discuss these questions during the session.

References

- Boaler, J., & Greeno, J. G. (2000). Identity, agency, and knowing in mathematical worlds. In J. Boaler (Ed.), *Multiple perspectives on mathematics teaching and learning* (pp. 171–200). Westport, CT: Ablex.
- Cobb, P., Gresalfi, M., & Hodge, L.L. (2009). An interpretive scheme for analyzing the identities

- that students develop in mathematics classrooms. *Journal for Research in Mathematics Education*, 40(1), 40–68.
- Cole, D. (2008). Constructive criticism: The role of student-faculty interactions on African-American and Hispanic students' educational gains. *Journal of College Student Development* 49(6), 587-605.
- Ender, S. C., & Kay, K. (2001). Peer leadership programs: A rationale and review of the literature. In S. L. Hamid (Ed.), *Peer leadership: A primer on program essentials* (Monograph No. 32, pp. 1-12). Columbia, SC: National Resource Center for the First-Year Experience and Students in Transition.
- Ellington, R. M. & Frederick, R. (2010). Black high achieving undergraduate mathematics majors discuss success and persistence in mathematics. *The Negro Educational Review*, 61(1-4), 61-84.
- Esmonde, I., Brodie, K., Dookie, L., & Takeuchi, M. (2009). Social identities and opportunities to learn: Student perspectives on group work in an urban mathematics classroom. *Journal of Urban Mathematics Education*, 2(2), 18–45.
- Griffin, K. A., Pérez, D., Holmes, A. E., & Mayo, C. P. (2010). Investing in the future: The importance of faculty mentoring in the development of students of color in STEM. *New Directions for Institutional Research, 2010* (pp. 95- 103). San Francisco, CA: Jossey-Bass.
- Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education*, 44(1), 37-68.
- Langer-Osuna, J. M. (2011). How Brianna became bossy and Ko came out smart: Understanding the differentially mediated identity and engagement of two group leaders in a project based mathematics classroom. *The Canadian Journal for Science, Mathematics, and Technology Education*, 11(3), 207–225.
- Martin, D. B. (2000). *Mathematics success and failure among African-American youth: The roles of sociohistorical context, community forces, school influence, and individual agency*. Mahwah, NJ: Lawrence Erlbaum Associates.
- McGee, E., & Martin, D. (2011). “You would not believe what I have to go through to prove my intellectual value!” Stereotype management among academically successful black mathematics and engineering students. *American Educational Research Journal*, 48(6), 1347-1389.
- McGee, E. & Stovall, D. (2015). Reimagining critical race theory in education: Mental health, healing, and the pathway to liberatory praxis. *Educational Theory*, 65(5), 491-511.
- Oppland-Cordell, S. B. (2014). Urban Latina/o undergraduate students' negotiations of identities and participation in an Emerging Scholars Calculus I workshop. *Journal of Urban Mathematics Education*, 7(1), 19–54.
- Shook, J. L. & Keup, J. R. (2012). The benefits of peer leader programs: An overview from the literature. *New Directions for Higher Education*, 157, 5-16.
- Valero, P. (2004). Socio-political perspectives on mathematics education. In P. Valero & R. Zevenbergen (Eds.). *Researching the socio-political dimensions of mathematics education: Issues of power in theory and methodology* (pp. 5–24). Norwell, MA: Kluwer.

Appendix

Peer Mentor Exit Interview Protocol

1. Tell us about your experiences as a peer mentor?

- a. Describe an impactful experience
 - b. Describe a challenging experience
2. How would you describe the STEM atmosphere at [the university]?
3. What successes have you had in your major?
4. What challenges have you had in your major?
5. Is there anything that set you apart from other students or students of color/female students in your program?
6. How do you think your different identities impact your experiences in STEM? Be sure to ask about positives.
7. Re-answer the application questions
 - a. Have you ever had an experience in a STEM class where you were made aware of your race and/or gender? If so, how did you respond?
 - b. Imagine you come across a 1st year student of color who is interested in becoming a STEM major. What types of advice would you give them to be successful at [the university] and in the major. Feel free to assume that they are interested in your major.
 - c. Imagine you come across a 1st year student who is interested in becoming a STEM major. What types of advice would you give them to be successful at [the university] and in the major. Feel free to assume that they are interested in your major.