



A Call to Action: Lessons Learned from a Book Club about Supporting and Mentoring Underrepresented STEM Students

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ABSTRACT

The participation rates of historically underserved students in Science, Technology, Engineering, and Mathematics (STEM) remains an important concern, as inequitable access in the form of treatment and opportunities within the education system is a constant struggle. To unpack this issue, a book club was organized as an intervention at a university in the southeastern part of the United States. Findings from the book club intervention suggest that university faculty should (a) understand the importance of continuous early exposure to STEM, (b) nurture underrepresented students' STEM identities, (c) form collaborations and partnerships with STEM professionals from underrepresented groups, and (d) commit to mentoring STEM underrepresented students. In this article, we argue that these objectives can be accomplished through the exposure to STEM professionals from underrepresented groups and the integration of STEM research in undergraduate coursework. Finally, we share the lessons we learned with respect to how the book served as our call to action in our professorial duties.

Keywords: Book Club, Mentoring, STEM

INTRODUCTION

The underrepresentation of culturally diverse students and perspectives in Science, Technology, Engineering, and Mathematics (STEM) fields remains a national challenge as evidenced in the continued underrepresentation of Blacks and Hispanics across STEM job clusters (Alvarado & Muniz, 2018). This lack of diversity within STEM suggests that there are racial and ethnic groups sitting with untapped STEM talent. As a result, these diverse perspectives are a critical omission from STEM fields. In the literature, however, mentoring is championed as an evidence-based practice that results in an increase of underrepresented students in STEM fields. Packard's (2016) text, *Successful STEM Mentoring Initiatives for Underrepresented Students: A Research-Based Guide for Faculty and Administrators*, unpacked some of these promising practices, and we participated in a faculty book club to dissect this text and personalize these strategies within our institutional context.

This article is organized as follows. First, we explore the relevant literature regarding the dynamic factors influencing the STEM experiences of underrepresented students, followed by a brief discussion on why mentoring matters. Afterward, we discuss the benefits of STEM mentoring, as well as the effective approaches for mentoring underrepresented students in STEM. Then, we describe the intervention—a book club to initiate discussions and outline effective measures surrounding STEM mentoring practices at our higher education institution. Lastly, to capture the urgency in the call to action in mentoring and supporting underrepresented students in STEM, we conclude the article with recommendations to redress the lack of diversity in STEM.

RELEVANT LITERATURE

STEM Experiences of Underrepresented Students

Unfortunately, many institutions serving historically underrepresented populations of students lack critical mentorship programs that could successfully motivate, encourage, support, and retain students in STEM. As a result, many historically underserved students struggle to overcome a variety of systemic challenges that negatively impact their access, opportunity, and ability to pursue STEM studies, thereby maintaining current racial and gender-based gaps in STEM education (Ramsay-Jordan, 2020; Stearns et al., 2016). These systemic hardships, most evident in PK-12 schools serving predominantly underrepresented students, often include inequitable school practices such as limited access to advanced mathematics and science courses.

Compared to other racial groups, Black children are among the most underserved who continue to have inequitable access to a high-quality STEM education (Collins, 2018). Enrollment in STEM courses for students attending predominantly Black PK-12 schools was significantly lower than that of students in predominantly White schools (Collins, 2018). Specifically, STEM courses primarily required for success in higher education such as calculus, chemistry, and physics had significantly lower enrollment rates for Black students. With limited access to STEM preparation courses in middle and high school, Black students have become less likely to pursue STEM studies at post-secondary institutions (Ramsay-Jordan, 2020).

Additionally, underserved students, particularly those from low socio-economic backgrounds, experienced subtractive schooling in forms of access to resources throughout their PK-12 education (Valenzuela, 1999). Consider, for example, access to and preparation for mathematics learning and understanding; researchers posited that since socio-economic status (SES) correlated to parents' accomplished level of education and the influence parents had on their children's prior knowledge of mathematical concepts, children from low-SES families entered elementary schools with lower mathematics skills than children from high-SES families (Basque & Bouchamma, 2016; Battey, 2013; Siegler, 2009). Their research tells us that differences in parents' SES have often resulted in differences in mathematical learning opportunities for students (Siegler, 2009), thereby making higher-SES parents more likely to engage their children in various mathematics activities as compared to lower-SES parents (Jordan et al., 2006). With inadequate preparation for challenging courses and minimal access to academically meaningful social activities, the noticeable absence of traditionally marginalized students from STEM studies is well-founded.

STEM Mentoring Matters for Underrepresented Students

With the type of subtractive schooling experiences many historically underrepresented students face, it is not surprising, therefore, that research studies call for deliberate and intentional mentoring centered on how to effectively increase the overall participation of these students. Researchers have examined the systemic exclusion of historically underrepresented students from pursuing STEM-related fields (Collins, 2018; Packard, 2016). Much of that literature called for effective mentoring to counteract systemic practices of selective exclusion and to increase STEM participation of historically underrepresented students. Packard (2016) wrote that mentoring is an indispensable strategy for broadening participation in STEM, for with it comes high-impact educational practices that increase student engagement and retention. Mentoring underrepresented students in STEM brings diversity

in human capital and innovation. Moreover, society is negatively impacted when STEM fields ignore the complex insights that arise from interactions and perspectives across race, gender, and socio-economic status (Packard, 2016).

Recent studies have shown that providing mentoring programs for historically underrepresented students who typically do not have appropriate access to foundational courses in mathematics and sciences, especially those with a need for supportive networks, had a greater impact on STEM recruitment and retention (Lancaster & Xu, 2017; Lisberg & Woods, 2018; Salto et al., 2014). Packard (2016) suggested that when underrepresented students have positive STEM mentoring experiences, they are more apt to achieve better grades and persist in college. Thus, mentoring is a critical component for increasing the motivation, encouragement, support, and participation of historically underrepresented students in STEM.

Benefits of STEM Mentoring for Underrepresented Students

Packard (2016) asserted that STEM mentoring of underrepresented students includes being intentional about developing students academically, increasing their capacity to learn, and encouraging persistence in STEM fields. STEM mentoring for underrepresented students can grow out of teaching, learning, and research that demonstrates a need for mentorship but goes beyond these functions. Other scholars made similar arguments. For instance, Carroll and Barnes (2015) suggested that effective mentoring establishes consistency, fosters mutual respect through the development of a safe space, and elicits positive mentoring experiences for underrepresented students in STEM. These scholars also stated that there is an active combination of professional (career) and psychosocial (supportive) functions that are developed through effective mentorship experiences.

Thomas (2001) asserted that five critical areas are achieved through effective mentoring of minoritized students: (1) gains in protégé professional competence; (2) positive reputations of high protégé performance, which leads to increased protégé confidence and credibility; (3) prevention of protégé derailment through focused career advice provided by the mentor; (4) powerful mentor sponsorship of the protégé; and (5) mentor protection of the protégé in unfair or unjust situations (which includes racial disparagement).

Because of the clear racial disparities in STEM, the benefits of STEM mentorship for broadening the participation of underrepresented groups remain crucially important. Societal changes in racial demographics show that a new collective majority-minority student population is on the horizon (Maxwell, 2014). However, the current state of affairs with a consistent predominantly White STEM teaching force (Stearns et al., 2016) and race-

based disparities in STEM fields (Lehming et al., 2013) make it essential for mentorship programs to seek integrative and diverse ways of supporting and designing STEM mentorship programs for underrepresented students.

A wealth of literature exists indicating that same race mentoring remains critical to the psychosocial development of minoritized students (Hall, 2015; Mondisa, 2018; Quigley & Mitchell, 2018; Sinanan, 2016). Same race mentorship interventions promote academic achievement, mitigate mental health issues from racial trauma (McGee & Stovall, 2015), and serve to ameliorate many of social and schooling challenges (Quigley & Mitchell, 2018). Its unmatched transformative and healing potential exists, particularly for Black students, in educational environments that are replete with positive role models, teachers, and mentors who care about them, understand them, and are committed to meeting their unique needs (Quigley & Mitchell, 2018). The psychological identification that same race mentoring provides is an important factor in the academic success, retention, and retainment of ethnic minority students (Mondisa, 2018; Sinanan, 2016).

Conversely, recent literature also points to the many benefits of integrated mentoring, thereby making effective mentoring unbounded by similar demographics between mentor and mentee and suggestive of advantages toward an integrative cultural approach to mentoring (Carroll & Barnes, 2015). Hernandez et al. (2017) found that similarity of values was the most important factor associated with integrated mentoring. They suggest that for integrated mentoring, protégé perceptions of high-quality mentorship was associated with a higher commitment to STEM careers. In their work, they reported that although some evidence indicates protégé gender and race may influence the quality of mentoring received, the amount of mentor-protégé contact and frequent interactions or long-lasting relationships were more impactful.

Approaches to Mentoring Underrepresented STEM Students

Higher education scholars have pointed to numerous strategies that emphasize mentoring as a central component that enhances identity development for Black students (Jones, 2000; Patton, 2009). In her research, Mondisa (2018) examined the mentoring approaches of 10 Black mentors who held at least one degree in a STEM field and had established experience mentoring underrepresented STEM students. The 10 Black mentors were solicited from academia, government, industry, and non-profit sectors who also had doctoral degrees and experiences across the educational continuum. In addition, the researcher selected 10 Black mentor participants who had national acclaim from their peers or national organizations for being exemplary mentors with underrepresented students. Mondisa (2018) found

that the mentors in her study used familial approaches to mentoring, an approach that involved sharing resources with students, and an empathic listening approach to connect and relate with their protégés. The approaches promoted the development of protégés' sense of community and STEM identities to support student persistence.

Packard (2016) suggested intentional and effective mentoring approaches start with knowing what the goals and intentions of the mentoring initiative are. She asserted that mentoring approaches such as events, programs, practices, and policies are complementary and collectively contributing factors of an institution's comprehensive strategy. Regarding events, Packard maintains that those are designed for specific purposes and are usually the beginning stages of intentional mentoring. Mentoring events often include one-time, intensive conferences, seminars, or career panels with featured speakers. Mentoring programs utilize an organized schedule of ongoing meetings to provide mentoring to its participants. As for practices, Packard described those as initiatives that embed mentoring into teaching and advising to improve mentoring that is already occurring. Lastly, policies centered on mentoring, according to Packard, are designed to increase student access, reallocate resources, assist with collaboration between departments, and could lead to commitments to diversity and inclusion as well as specific mentoring outcomes. Irrespective of the approach, intentional and effective mentoring of underrepresented students aims to validate and further cultivate student interest and persistence in STEM.

ADVANCING THE CONVERSATION

Research has consistently demonstrated that supportive learning environments positively shape STEM experiences and outcomes of historically underrepresented students (Carroll & Barnes, 2015; Hernandez et al., 2017; Quigley & Mitchell, 2018). Specifically, mentoring programs with nurturing psychosocial environments, marked by supportive peer and faculty interactions improved academic outcomes of underrepresented students in STEM (Oates, 2004). To this point, we, the authors of this manuscript, posited that the effectiveness of any mentoring program will undoubtedly require faculty support. Therefore, to get faculty involved and to help them see the importance and value of STEM mentorship programs for historically underrepresented groups, a book club was designed in this institutional context.

Book clubs are common practice at many institutions of higher learning. Covering a variety of topics, participation in book clubs encompasses the sharing of ideas, encouragement, and support that could ignite positive changes for faculty, students, and ultimately institutions. For

the authors of this manuscript, these aspects of book clubs seemed a profound way to spark interest, support, and commitment to understanding and acting on the need to mentor underrepresented students in STEM. Even more, the value of sharing ideas, as associated with book clubs, could prove to be beneficial in improving the STEM experiences of underrepresented students. Consequently, as an intervention strategy for increasing the participation of underrepresented students in STEM, the authors of this manuscript utilized a book club to share knowledge with and solicit feedback from faculty at their institution of higher learning.

The Book Club Intervention

The book club intervention took place at a regional, comprehensive university in the southeastern United States. A call was sent out to all of the university faculty members to join the book club via the institutional all-faculty listserv. The goal was to attract at least 10 faculty members who had a shared interest in bolstering the STEM identities of underrepresented students to participate. Some faculty members wished to join the important discussion but expressed that they were unable to do so because of course conflicts or other prior commitments. Fortunately, 10 faculty members signed up for the book club with one faculty member eventually dropping due to additional workload. Therefore, in the end, nine faculty members participated in the book study, which included four faculty members from the College of Education (COE) and five faculty members from the College of Science and Mathematics (COSM). Collectively, the faculty members represented both STEM education and STEM faculty, which was not surprising given the book club's focus. This balance between the two colleges provided different disciplinary perspectives to enrich the conversations about mentoring underrepresented STEM students.

The book club met monthly to dissect the book's content, and the second author of this manuscript, led the meetings by generating opening activities and discussion questions for each meeting. The meetings occurred on Mondays for 1.5 hours. This day was chosen given the second author's participation in previous book club meetings at the institution. To add some context, a previous book club meeting occurred on a Friday afternoon, which resulted in many conflicts because of weekend travel, conferences, and other obligations. Another book club met on Wednesday, which resulted in numerous conflicts given the challenges that occur mid-week. The Monday meetings worked favorably in this scenario as care was taken to consider STEM (education) conferences, institutional events, and local STEM affairs. Additionally, Monday meetings allowed faculty members to read and reflect on the chapters during the prior weekend. Overall, the Monday meetings

worked well, as very few conflicts arose that prevented colleagues from attending the scheduled meetings.

The Selected Book

Packard's (2016) text was chosen for several reasons. First, there are national discussions concerning the underrepresentation of women, minoritized groups, and students with disabilities in STEM, and it is well-documented that the STEM community does not reflect the country's diversity (Allen-Ramdial & Campbell, 2014; National Science Foundation, 2015). Also, our institution is one that has a large number of underrepresented students pursuing STEM degrees at a given time, yet a vast number who declare STEM majors but eventually switch to non-STEM majors. Therefore, the text was selected to explore and propose solutions to mitigate these issues for underrepresented students within this institutional context.

In addition, we, the authors of this manuscript, wanted to read and examine this book in community with other faculty members to augment our professional growth and development as mathematics educators. As mentioned, we are both African American, and we each have experience supporting underrepresented students in mathematics contexts. Our mathematics education scholarship indicates that this work is sorely needed in our disciplinary field (Jett, 2019; Ramsay-Jordan, 2020). The next section advances this conversation by extracting the lessons we learned.

LESSONS LEARNED

Embracing New Pathways: Natasha's Lessons Learned

My primary takeaways from the book club included: (a) nurturing STEM identities for underrepresented students; (b) understanding the importance of continuous early exposure to STEM; and (c) forming collaborations and partnerships with STEM professionals from underrepresented groups. Sinanan (2016) observed that it is common for underrepresented faculty members, particularly ones teaching at PWIs, to mentor underrepresented students without it being a formalized process. Previously, I worked as a secondary mathematics teacher where I deliberately cultivated and supported a healthy STEM identity among my students. In my mathematics courses, students' mathematics confidence was continuously nurtured and supported in hopes of emboldening students with the knowledge that they were capable of being anything, including a scientist, engineer, or mathematician. Hughes et al. (2013) argued that stimulating healthy STEM identities and abilities can increase representation in STEM. Thus, developing positive STEM dispositions in underrepresented students is a great start toward changing current STEM education demographics. The importance of

cultivating students' STEM identities was further explored in the book club as essential for improving the STEM education experiences for underrepresented students.

According to Packard (2016), continued support and nurturance of a STEM identity is critical for underrepresented students pursuing STEM. Since the book club, I have been more cognizant about continuing to enter classrooms, offices, and other campus spaces intentionally encouraging students, particularly the many impressionable underrepresented students, to persevere in their STEM pursuits. In doing so, I continue to steer students into becoming more effective communicators, problem solvers, and ethical agents for change through mathematics. I assist with transforming a student's classroom experience to one where they learn how to think not just about numbers, but also how to collaborate effectively to solve problems, how to acquire knowledge, and how to nurture their STEM ambition. Additionally, in my current capacity as a teacher educator, I mentor and advise teachers of their role as change agents using STEM to further social justice.

Another lesson learned from the book club is to have a clearer understanding of the importance for students in grades K-12 to have continuous early exposure to STEM. The importance of early introduction to STEM as a positive way to leverage current negative experiences of underrepresented students in STEM is supported in prior work (Leonard et al., 2016; Young et al., 2017). These scholars suggest, for example, that there is a need to work with young girls in K-12 settings and women to prepare, develop, and support their increased participation in STEM. Understandably, this work challenges preconceived ideas about who belongs in STEM and helps women to endure current experiences of gender disparities in STEM. Since the book club, I have collaborated with neighboring schools and organizations to expose students to STEM learning and careers. In particular, I have embedded STEM inclusion projects that require pre-service teachers to speak specifically about how they will address equity in STEM as well as require them to invite diverse representatives from STEM fields into their classroom.

Another key takeaway from the book club is the need and importance of collaboration or partnerships with STEM professionals and leaders from underrepresented groups. One-on-one contact with STEM leaders and professionals from underrepresented groups is significant for underrepresented students. In fact, researchers state that interacting, collaborating, and building relationships with diverse STEM leaders and professionals has the propensity to prime the STEM nexus for underrepresented groups (Hughes et al., 2013; Leonard et al., 2016; Young et al., 2017). Recognizing these important pathways to improve the STEM

experiences of underrepresented groups, I inculcate these practices and more into mathematics courses by requiring prospective and practicing teachers to identify ways in which their students will be exposed to STEM in both formal and informal ways.

From Intervention to Action: Christopher’s Lessons Learned

I draw from my collegiate mathematics teaching experiences and positionality as a Black male researcher to influence what I took away from the reading and book club discussion of Packard’s (2016) text. Two primary takeaways that drive this discussion include: (a) the exposure of mathematics professionals from underrepresented groups and (b) the integration of research in undergraduate coursework for future mathematics practitioners.

Table 1

Pre-Service Teachers’ Selected Underrepresented Mathematician

Pre-service teacher	Mathematician	Underrepresented group	Reason for Selection
Amy	Alberto Pedro Calderon	Hispanic Man	Work in the Area of Partial Differential Equations
Beth	Anthony Bonato	Canadian Man	LGBT+ mathematician who is still alive
Carrie	Sofia Kovaleyskaya	Russian Woman	Father used old calculus notes as wallpaper in her room
Deborah	Evelyn Boyd Granville	African American Woman	Profiled in <i>Women Becoming Mathematicians</i> (Murray, 2000)
Elizabeth	Katherine Johnson	African American Woman	Profiled in <i>Hidden Figures</i> (Shetterly, 2016)
Frank	Ruth Gonzalez	Hispanic Woman	First Hispanic woman to receive a Ph.D. in mathematics

Because I taught a mathematics course for future secondary mathematics teachers during the semester following the book club meeting, I was able to

move from intervention to action immediately. Notably, the course had six students enrolled as this course is only required for mathematics majors on the secondary education track.

Exposure of Mathematics Professionals from Underrepresented Groups.

One takeaway was to highlight mathematics professionals from underrepresented groups throughout the entire semester (Packard, 2016). Although I have done something similar in previous semesters, this text reminded me to be more strategic about doing so within the current semester. Pre-service secondary mathematics teachers selected an underrepresented professional, based on their interests, and conducted research on this individual. As such, students were charged with locating information, writing a paper, and giving a presentation about the selected underrepresented mathematician or mathematics educator. The presentations were given every few weeks, and each student was allotted approximately 10 minutes of class time to profile the underrepresented professional. Table 1 below includes their selections. In the accompanying tables, please note that pseudonyms are used instead of pre-service mathematics teachers’ real first names.

Table 2

Pre-Service Teachers’ Research Topic

Pre-service teacher	Social justice research topic	Mathematics research topic
Amy	Abortion	Probability
Beth	Racial Profiling	Proportions
Carrie	Criminal Justice System & Racial Discrimination	Average Rate of Change
Deborah	Pollution	Pollution Standards Index
Elizabeth	Unequal Pay Gap	Financial Literacy
Frank	Unequal Distribution of Wealth	Average Concepts

Integration of Research in Undergraduate Coursework for Future Mathematics Teachers.

Another lesson learned was to integrate a research component into my existing mathematics course (Packard, 2016). In doing so, I consulted the literature on Course-based Undergraduate Research Experiences (CUREs)

(Bangera & Brownell, 2014) and exposed students to relevant literature with social justice aims (Gutstein & Peterson, 2013; Wager & Stinson, 2012). In this secondary teacher preparation program, students learned about reform-based and project-based instruction, and the CURE brought to life what they were learning in their education coursework. Table 2 below lists pre-service mathematics teachers' social justice research topics and their related mathematics research topics. Interestingly, these social justice topics are ongoing issues affecting underrepresented groups at disproportionate rates.

CONCLUSIVE THOUGHTS

As this article shows, participating in this book club caused us to be more deliberate and strategic about supporting and mentoring underrepresented students in STEM. Stated differently, the book club meeting and the resultant ideas caused us to take action. Examples included nurturing STEM identities, exposing students to mathematics professionals from underrepresented groups, and integrating research with social justice aims. Therefore, this book club exploration achieved our goal of bringing faculty members together to explicitly advance conversations about supporting and mentoring underrepresented students in STEM.

Implications for Future Work

Regarding future work, the book club meetings generated fruitful implications derived from the contents of the book (Packard, 2016) as well as members of the book club. These suggestions included designating a portion of faculty office hours to mentoring, bolstering skills needed for the STEM workforce, and cultivating STEM talent (as opposed to merely seeking to identify it). Other suggestions that would require more heavy lifting included offering a first-year seminar course for underrepresented STEM students, designing faculty learning communities for sustained advancement of these conversations, and creating a "Diversity in STEM Day" event.

Since the book club, the first author of this manuscript has developed and taught a first-year seminar course to address issues of race and gender in STEM. The second author has planned a symposium to expose underrepresented groups to the career possibilities associated with a mathematics degree, with a targeted focus on Black male students, given his research agenda centered on this population of students. As it pertains to our future institutional work specifically, we are planning university-wide events to expose students to minoritized STEM professionals. We are also exploring funding opportunities such as the National Science Foundation's S-STEM program to support underrepresented students in STEM. In all, this future

work will allow us to act on the lessons learned from the book and the book club discussions.

Limitations

There are some limitations associated with this work. First, this book club was designed as a professional development opportunity for faculty to advance *conversations* about underrepresented students in STEM. Adding a research component to this book club could have provided additional insights to advance *scholarship* regarding efforts to support underrepresented students in STEM. While this article advances scholarship in some ways, a traditional research study would have done so in more substantive ways. Another limitation was that the book club only included faculty members from the COE and COSM—faculty who represent STEM education. Faculty from the arts, humanities, or social sciences could have offered diverse disciplinary perspectives to enrich the conversations. Finally, a limitation was that our book club did not include any institutional leaders or administrators (i.e., department chairs, deans, etc.). Although institutional leaders had some interests in this topic and were invited to join the book club, the demands of administrative roles prevented them from doing so. Nevertheless, including institutional leaders would have advanced the conversations further by including administrative points of view.

CONCLUSION

In concluding this article, if we are committed to mentoring and supporting minoritized STEM students, then we must employ evidence-based practices that foster the attainment of STEM educational outcomes. As we have expressed, designing a faculty book club to synthesize, reform, and generate ideas with respect to different institutional contexts could be a first step in establishing efforts to effectively mentor underrepresented students in STEM. Next, our plan is to put these ideas into action. In addition, readers are encouraged to capitalize on our lessons learned to further include diverse perspectives in their STEM education work. Ultimately, our hope is for underrepresented STEM students to be provided with the necessary support and mentoring to achieve their goals, and we hope that what we learned from this book club serves as a call to action for faculty members and other institutional stakeholders to implement support and mentoring structures for the advancement of underrepresented students in STEM.

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