A Blended Peer Mentoring Experience for Undergraduate Minority Mentees in STEM Programs at Two HBCUs

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Abstract

A blended peer mentoring program for minority students in STEM degree programs was piloted at two historically black institutions (HBCUs). The program included peer mentoring of minority undergraduate mentees in STEM by minority graduate mentors in STEM. A mixed methods approach was used in the investigation. Mentees' intent to persist in STEM degrees and careers, self-efficacy, and STEM career interest were measured and compared to a waitlist control group. The mentees had higher STEM achievement and career self-efficacy; higher interest in science, engineering, and mathematic careers; and more intent to persist in their STEM degrees and a STEM career compared to the control group. Interviews, focus groups, and review of documents demonstrated how and why the experience influenced mentees' beliefs, interests, and persistence.

Purpose

In the 2018-2019 academic year, a blended peer mentoring program was piloted across two HBCUs with the aim to broaden the participation of minorities (NSF, 2019) and, in particular, racial and ethnic minority women in STEM. The program followed a mixed methods approach and explored how and in what ways mentees' participation in the program influenced their STEM self-efficacy, STEM career interest, and intent to persist in STEM degrees and careers compared to a wait list control group. Despite efforts to increase participation of historically underrepresented populations, a disparity continues to persist in the number of minorities and the number of women (including women who simultaneously identify as racial and ethnic minorities) who engage in STEM programs and careers (NSF, 2019). This is, in part, due to women and racial and ethnic minorities having few "like others" to serve as role models for persisting in STEM (Olson & Riorda, 2012) and few mentors (Chan, 2018), contributing to lack of self-efficacy and belief that they belong in and can succeed in STEM. Engaging in mentoring opportunities, including peer-mentoring opportunities, can assist in addressing these concerns and in broadening participation of women and racial and ethnic minorities in STEM degrees and fields.

Theoretical Framework

The study is grounded in Tinto's (1987; 1993; 2017) Institutional Departure Model, which surmises that personal attributes (e.g., race, gender, and culture, family backgrounds such as socioeconomic status and level of parental education) and previous experiences influence individuals' performance, experience, and STEM degree attainment directly and indirectly. Individuals' persistence is further influenced by integration into the STEM community, which in turn influences individuals' institutional and discipline-specific commitment and likelihood to persist in a STEM degree and career. Study has supported that formal mentoring experiences are important in supporting and sustaining the participation of ethnic and racial minorities and women (Yosso, 2005).

The study is further grounded in Social Cultural Career Theory (SCCT; Lent, Brown, & Hackett, 1994). SCCT, grounded in Bandura's (2006) self-efficacy framework, upholds that individuals' interest promotes their intention, influencing the choice to enroll in STEM courses and pursue STEM degrees and careers. Interest inspires action and experiences provide feedback that cyclically influences self-efficacy and performance outcomes. Additionally, individuals' self-efficacy and beliefs influence attainment of specific performance outcomes, motivation, goal setting activities, and persistence. SCCT is a widely used framework in understanding choices to engage in the overall STEM environment (Anagnos, Lyman-Holt, Marin-Artieda, & Momsen, 2014; Fouad et al., 2016). Further, studies demonstrate that self-efficacy is an especially important construct for those historically underrepresented in STEM (Anagnos et al., 2014; Fouad, Fitzpatrick, & Lou, 2011; Ireland et al., 2018; MacPhee, Farro, & Canetto, 2013).

Methods

As the current study was undertaken to explore how and in what ways peer mentees' participation in the program influenced their beliefs, interests, skills, and behaviors, the following research questions were asked:

- RQ1: To what extent, if at all, did participating in the blended peer mentoring experience influence peer mentees' STEM beliefs, interests, skills, and behaviors compared to a wait list control group?
- RQ2: How, if at all, did participating in the blended peer mentoring experience influence peer mentees' STEM beliefs, interests, skills, and behaviors?

To answer these questions, a mixed methods approach was undertaken (Creswell, 2013). Undergraduate students enrolled in STEM programs across two participating HBCUs in the mid-Atlantic region of the United States were invited to be peer mentees in the blended peer mentoring program. Through a rigorous application process, 21 mentees were invited to participate in the program. These participants were placed in groups of 3-4 and assigned to a peer mentor. The peer mentors were graduate students enrolled in STEM programs at the participating universities who identified as women and racial and ethnic minorities. The mentees were required to be a woman and/or racial or ethnic minority in STEM, be enrolled in a STEM degree program, have a cumulative GPA of 2.8 or higher, and provide a letter of recommendation from a STEM faculty member upon request. Twenty-six students served as the waitlist control group and participated in the quantitative data collection. The sample population of mentees consisted of two males (50% Black, 50% Hispanic), 18 females (99.5% Black, .05% Mixed Race), and 1 transgender student (100% Black). The waitlist control demographics were similar, and chi-square analyses demonstrated that the two groups did not significantly differ in race or gender identity.

Data Sources

Data were collected from the mentees and waitlist control group via a survey in the final week of the program. The survey consisted of bipolar closed-ended questions related to intention to persist and personal development as well as items to measure self-efficacy (STEM SE) and STEM career interest (STEM-CIS; Kier, Blanchard, Osborne, & Albertt, 2014). Additionally, during the final week of the program, the mentees participated in semi-structured interviews and focus groups. To further ensure the trustworthiness of the data, the researchers reviewed the mentors' weekly mentoring notes, which confirmed data collected in the survey and interviews

(Creswell, 2013; Yin, 2014). Individual semi-structured interviews and focus groups were recorded and transcribed verbatim. Qualitative data were analyzed inductively. The interview transcripts and the documents were read, re –read, and then free-text coded by one of the researchers. These emergent codes were collated into categories and themes. The emergent codes, themes, and codes were discussed with the other researcher until agreement was reached (Lincoln & Guba, 1989, Yin, 2014). Member checking of transcripts and themes with a random selection of mentees then occurred to ensure trustworthiness. The graduate mentor experience was investigated in another inquiry (Rockinson-Szapkiw & Wendt, in progress).

Results

Descriptive statistics for the peer mentors and the wait-list control group data were computed (Table 1). A series of independent samples *t*-tests were conducted to evaluate whether the program promoted self-efficacy, and in turn, mentee's STEM career interest. Prior to conducting each independent samples *t*-tests, assumption of normality, homogeneity of variance, and extreme outliers were examined. While there were minor violations of normality, the independent-samples *t*-test is considered robust to violations of normality and requires only approximate normal distribution of data (Warner, 2013). It is not uncommon for the distributions to be non-normally distributed especially as sample sizes increase, thus, due to the Central Limit Theorem, the independent samples *t*-test can still provide valid results. There were no violations in the assumptions of homogeneity of variance as evidenced by the results of Levene's test of equality of variances. Boxplots revealed no extreme outliers. Results of the analyses demonstrated that the peer mentee group compared to the wait-list control group had statistically significant higher STEM achievement and career self-efficacy (see Table 1). With the exception of having higher interest in a technology career, the peer mentee group had a significantly higher interest in science, engineering, and mathematic careers compared to the wait-list control group.

Additionally, two chi-square tests for independence were conducted to evaluate whether intent to persist differed between the two groups. Prior to conducting the analysis, assumption testing was completed. The assumption of minimum expected cell frequency was violated. Thus, the Fisher's exact tests were run, and the results demonstrated that individuals in the peer mentoring group intend to persist in their STEM degrees and a STEM career at a significantly higher proportion than those not participating in the program (Table 1).

Evidence from the semi-structured interviews and focus groups, as well document analysis, supported the findings of the quantitative analyses demonstrating that the blended peer mentoring experience influenced mentees' beliefs, interests, and persistence. Initial data analysis revealed the following themes: 1) Conditions for Trust and A Sisterhood (including individual mentee dynamics and relational dynamics), 2) Opportunities within a Sisterhood, 3) Experiences that Motivated Change, and 4) Positive STEM Outcomes. Within the blended peer mentoring experience, the mentees related that the graduate mentors developed conditions for the development and maintenance of a sisterhood. The mentees identified several individual characteristics of mentors as foundational to building trust, and, ultimately, community or a "sisterhood", as several mentees described, in a peer mentoring relationship. Trustworthiness and authenticity were the first to be discussed by most mentees. A mentor's accepting, non-judgmental, and caring attitude, much akin to what Rogers (1959) identified as unconditional positive regard, was also readily recognized across interviews. The concept of match/fit was discussed and verified through numerous individual interviews and in the focus groups. Mentees identified a "good fit" or match with mentors who shared gender characteristics, race/ethnicity

characteristics, and degree area. Lack of match was sometimes considered evidence of the mentor's low capacity to provide academic, psychosocial, and personal support and information needed. Shared demographic characteristics and degree area were described as engendering trust development and facilitating community building, aligning to similar existing research (Chan, 2018; Ireland et al., 2018).

Table 1. *Descriptive Statistics and Results of the Independent t-Tests*

Scale	Mentees (n =21)		Wait- list Control (n =26)				
	M	*SD*	*M*	*SD*	*t*-value	*p*-value	Score range
STEM SE Achievement	111.762	25.347	96.500	17.328	2.446	.018*	10-140
STEM SE Career	109.809	24.479	94.000	21.141	2.375	.022*	10-140
Science Career Interest	45.857	7.780	41.154	9.094	2.193	.034*	11-55
Math Career Interest	44.762	9.219	36.154	11.976	2.707	.010*	11-55
Engineer Career Interest	36.048	14.654	27.231	11.382	2.323	.025*	11-55
Technology Career Interest	44.952	10.092	41.077	12.358	1.158	.253	11-55
Open-ended Question	Yes	No	Yes	No		*p*-value	Responses
Do you plan to pursue a career in the area in which you are obtaining a degree?	20 (95.2%)	1 (4.8%)	16 (61.5%)	10 (38.57%)		.014*	Yes/No
Do you intend to graduate from your STEM degree program?	20 (95.2%)	1 (4.8%)	19 (73.1%)	7 (21.6%)		.049*	Yes/No

Note. SE = self-efficacy; * $p < .05$

The mentors' competence communication and behaviors also played an important role in laying a solid foundation in the peer mentoring relationship according to the mentees. Self-disclosure and the use of active listening created trust and setting of expectations and boundaries. Building trust, and ultimately community/sisterhood, also required responsibility, engagement, and reliability of the mentees. While these were identified as behaviors and characteristics of the mentors foundational to trust and sisterhood building, the mentees recognized that they, too, needed to invest in the peer mentoring relationship. In other words, the peer mentoring relationship needed to be reciprocal in nature and responsibility for the relationship shared. The sisterhood further maintained between and among the mentees and mentors through sharing experiences and vision on an academic, psychosocial, and personal level.

Sharing with one another and employment of mentor functions (e.g., information sharing, problem solving, role modeling, etc.) were experiences that generated experiences mentees had that resulted in change. Experiences within the peer mentoring experience that became mechanisms for change included: 1) Growth and Development (e.g., knowledge about the state of women in STEM, career opportunities, internship experiences), 2) Recognition (encouragement, trust, belief), 3) Meaningful Reflection (goals, values, beliefs), and 4) Challenge (problem solving, encouragement to take risks, meaningful feedback on reaching goals and progress). Experiencing these things helped mentees envision themselves as racial and ethnic minority women in STEM, build self-efficacy, and encourage interest, which, in turn,

solidified their STEM career interest and commitment to persist in their STEM degrees. Figure 1 provides a model of findings.

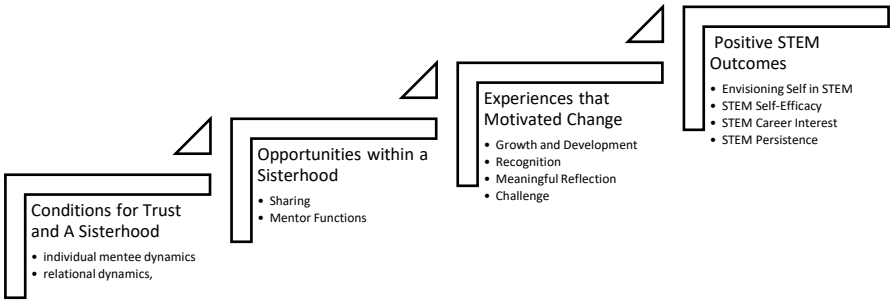

Figure 1. *Model of findings.*

Scholarly Significance

The benefits of mentoring on historically underrepresented populations, including racial and ethnic, as well as gender minorities, has been well documented within the research literature (Chan, 2018; Ireland et al., 2018). However, most study has focused on faculty mentoring of students or mentoring primarily conducted in the research laboratory, has been situated within predominately white institutions, or has been conducted in primarily face-to-face environments. Despite the dearth in research on the experiences of minority undergraduate students at HBCUs from a psychosocial standpoint, the benefits of mentoring have potential to support the interest in, engagement in, and persistence in STEM among minorities and women. Peer-mentoring, additionally, given its reciprocal nature and removal of hierarchical structure, can yield additional benefits that, in turn, develop belongingness and community. In the present study, the experiences of undergraduate women and racial and ethnic minority mentees supported that engagement with graduate minority mentors was beneficial to enhancing interest in STEM, encouraging persistence in STEM, and building STEM self-efficacy. Further, the qualitative findings in the current study yield important insight regarding the characteristics of mentors that best facilitate and foster successful mentoring relationships from the mentees' perspectives, leading to the development of a model for peer mentorship among minority STEM students. The findings from this study contribute greatly to the body of knowledge and will serve as a foundational model on which future blended peer mentoring relationships can be built and fostered among other HBCUs and minority serving institutions, with the potential to broaden participation in STEM.

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