Journal of Women and Minorities in Science and Engineering 27(6):1–20 (2021)

RETAINING UNDERREPRESENTED STUDENTS IN BIOLOGY: OUTCOMES OF A CULTURALLY RESPONSIVE INTERVENTION ON PERCEPTIONS OF SUPPORTS AND BARRIERS

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Career development provides avenues for educators to help shape academic interests, career goals and expectations, and facilitate the development of relevant skills (Lent et al., 2005). Despite literature suggesting benefits from incorporating student values into STEM course content to make lessons personally meaningful (Harackiewicz et al., 2014; Vincent et al., 2012; Jones and Larke, 2003), formal career development interventions are often lacking, replaced by individual advising and mentoring (Byars-Winston et al., 2011). This study utilizes a culturally responsive intervention with the aim of improving retention of underrepresented biology students. Students' perceptions of supports and barriers (measured by SCSBS, Lent et al., 2003; and SESBS, Lent et al., 2005) were examined before and after the intervention. Results indicate significant differences between pre- and post-test scores in the intervention group. This may suggest a change in insight, which could lead to the establishment of more realistic expectations, thus increasing student retention.

KEY WORDS: *African American students, biology, career development intervention, HBCU, retention, SCCT, STEM*

1. INTRODUCTION

Career development provides an avenue for educators to help shape students' academic interests, career goals, and expectations, as well as facilitate the development of relevant skills (Lent et al., 2005). Undergraduate education has been identified as the time when most educational and career choices are shaped, rendering career development during this time particularly salient (Sharf, 2016). Research suggests that African American undergraduate students may have unique career development needs as compared to those of White students. This may occur because these students face additional barriers, such as discrimination and internalized negative stereotypes (Gysbers et al., 2014). African American students may also have different career decision-making attitudes and

work values that are not adequately considered in current career development theories (Fouad and Bingham, 1995). While career development interventions promote students' commitment to their education and academic achievement (Fouad and Bingham, 1995; Brown and Krane, 2000), many career development methods are normed on European groups and should not be applied across cultural groups (Worthington et al., 2000). The purpose of this study is to address career development needs of undergraduate African American science, technology, engineering, and math (STEM) students by investigating the efficacy of a culturally competent career development intervention.

1.1 STEM Majors and Career Development

Traditionally, STEM majors learn about career management through advising and mentoring (e.g., Hrabowski and Maton, 1995; Maton et al., 2000; Byars-Winston et al., 2011), particularly by working closely with a mentor to gain research experience (e.g., Maton et al., 2000; Siritunga et al., 2011). While skilled at incorporating the personal experiences of teachers and researchers, this method is not without faults. For example, this practice does not take advantage of research- and theory-based knowledge and interventions on career management and decision-making techniques that improve academic persistence and performance in STEM fields (Brown and Krane, 2000). Recent studies identified the benefit of incorporating student values into course content to make lessons personally meaningful for STEM student career development (Harackiewicz et al., 2014; Vincent et al., 2012; Jones and Larke, 2003). For example, Harackiewicz et al. (2014) implemented a values affirmation intervention with first-generation biology students and found a significant improvement in course grades and retention in biology. Nevertheless, the research on career management in STEM majors remains focused on students in the process of selecting majors (e.g., Rayfield et al., 2013), with little emphasis on supporting students already committed to a STEM career path (Herr et al., 1993). These approaches may not be adequate for addressing the specific career development needs of African American students in STEM (National Science Foundation [NSF], 2015). Additional research is needed to investigate the efficacy of culturally sensitive career development methods designed to address the unique needs of these students.

1.2 African American Underrepresentation in STEM

African American students are identified as an underrepresented minority group across all STEM fields (NSF, 2014). The persistence of minorities in STEM fields is commonly referred to as a "leaky pipeline," with over half of STEM students leaving their major before completing an academic degree (Russell and Atwater, 2005). For example, in 2009, approximately half of the African American students who intended to major in a STEM field actually graduated with a STEM degree (NSF, 2014). Due to limited research on the career development needs of African American STEM students (Russell and Atwater, 2005; Maton et al., 2000; Bonous-Hammarth, 2000), it is unclear how a lack of career development skills influences African American STEM students' persis-

tence. This current study investigates the efficacy of a theoretically driven, research based, and culturally competent career development intervention that addresses the unique career development needs of African American STEM students by incorporating and applying social cognitive career theory.

1.3 Social Cognitive Career Theory

Social cognitive career theory (SCCT) (Lent et al., 1994, 2000) of career development is rooted in Bandura's (1997) social cognitive theory. It purports to provide insight into internal and external factors that influence an individual's career choice behavior. In particular, SCCT takes into consideration a person's self-efficacy, interests, and outcome expectations (internal factors), as well as environmental supports and barriers (external factors) that support or impede career development (Lent et al., 2000). Distal factors, such as race/ethnicity, gender, and learning experiences, also impact perceived self-efficacy and outcome expectation contrast with factors that more immediately impact career decision making in the moment (proximal factors). One little-studied variable in this model is that of socioeconomic status. Thus, the combined effect of these internal, external, proximal, and distal factors influences academic achievement and performance (Lent and Brown, 2013) (Fig. 1).

SCCT literature in STEM fields emphasizes the importance of self-efficacy, which refers to a person's belief in his/her ability to perform a particular behavior or course of action. According to SCCT, self-efficacy has a central role in influencing career interests, goals, and outcomes (e.g., Lent et al., 2001; Byars-Winston et al., 2010; Hurtado et al., 2008). Research suggests that African American STEM student retention and performance are positively impacted when career development is expanded beyond self-efficacy. Other external and distal factors that have been identified as being impactful include values-based and culturally relevant content in classroom instruction (Siritunga et al., 2011; Cohen et al., 2006), as well as the involvement of parental support (Byars-

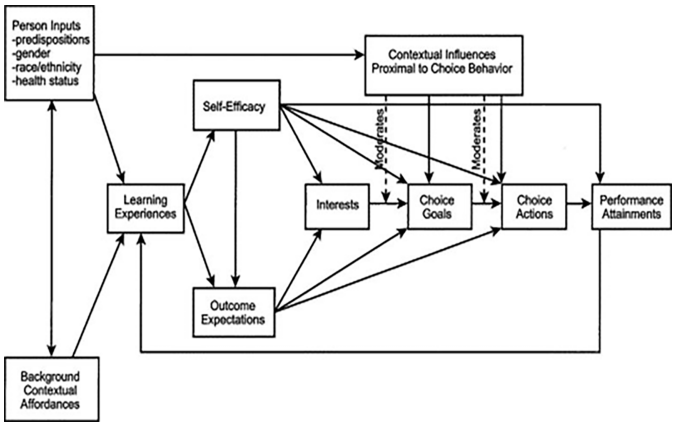

FIG. 1: Social cognitive career theory model. Adapted from Lent et al. (1994).

Winston and Fouad, 2008). Additionally, African American STEM students may face contextual barriers, such as institutional selectivity, which may hold value systems aimed at White students, reinforcing negative and harmful racial stereotypes (Bonous-Hammarth, 2000). For example, Rath et al. (2007) found that underrepresented minority students are often from backgrounds that are less supportive of college attendance, have lower-quality schooling preceding college, and experience negative stereotypes and isolation on college campuses. Consequently, effective career development with African American STEM students should address these additional factors and barriers.

1.4 Effectiveness of Career Development Interventions

Research on the effectiveness of career development interventions supports the positive impacts that career interventions have on participants (Spokane, 1991; Hardesty, 1991). Studies suggest that career development interventions are related to improvements in academic major/career choice (Halasz and Kempton, 1997), career decision-making skills (Savickas, 1990), and retention (Krause, 1998). In a review of 25 articles examining the outcomes of career development interventions with STEM students, 100% identified improvements in career management skills including career choice (Sweeney and Villarego, 2013), clarity in career goals (Esters and Retallick, 2013), and academic performance (Harackiewicz et al., 2014). Brown and Krane (2000) conducted a meta-analysis investigating the important components of effective career interventions. The outcome of this analysis identified five components that improved the effectiveness of career intervention: (1) workbooks/written exercises, (2) individualized feedback, (3) world-of-work information, (4) modeling effective planning/coping strategies, and (5) attention to building support within social network (Brown and Krane, 2000). The integration of more than one of these components improved the intervention's effectiveness (Brown et al., 2003).

1.5 African American Career Development

Research with underrepresented minority STEM students overwhelmingly focuses on the use of surveys to gather information (e.g., Helms and Cook, 1999; Gainor and Lent, 1998; Lent et al., 2005; Byars-Winston et al., 2011; Byars-Winston, 2014). Searches of the literature for research on the career development of African American "STEM" or "Science, Technology, Engineering, and Mathematics" found a total of seven publications and three dissertations, all of which explored one or more variables in relation to African American STEM students, rather than interventions that develop relevant skills and/or knowledge. Since 2000, only two NSF awards focused on broadening participation of racial and ethnic minority students (NSF, n.d.). This highlights the need for research on the efficacy of career development interventions with African American STEM students. The current study targets the gap in the literature by investigating the efficacy of a career development intervention that is theoretically driven, research based, and culturally competent.

In general, career counseling methods have been normed primarily on European American groups and should not be applied across cultural groups (Worthington et al., 2000). Effective career development interventions with African American STEM students must be grounded in culturally competent information. Fouad and Bingham (1995) proposed that career development is influenced by individual and environmental variables. Environmental barriers uniquely influence underrepresented minorities in the form of racism, acculturation, cultural values, and political and economic systems. To address these environmental barriers, Fouad and Bingham (1995) developed the culturally appropriate career counseling model (Fig. 2), which emphasizes the integration of culture into career development. This process was used in developing the intervention implemented in this study. Thus, the concept of cultural awareness was emphasized. This was done by addressing Afrocentric values, using visual examples of African Americans in STEM, and incorporating information about issues faced by African American students in STEM careers into the interventions.

1.6 Purpose

The present study was designed to evaluate the effect of a culturally appropriate, major-focused, SCCT-based intervention to assist African American STEM majors in the development of an understanding of the steps toward a successful career in STEM fields, while also increasing their career management skills. Research-based (Brown and Krane, 2000; Lent et al., 2003; Byars-Winston et al., 2010) and theory-driven (Fouad and Bingham, 1995) career development activities and information were included to achieve the goals of this study, which were to

- Determine if there are differences on the measures of supports and barriers between groups based on sex.

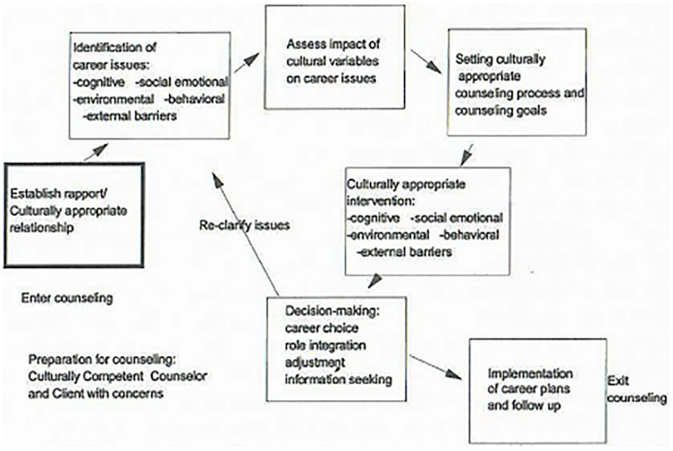

FIG. 2: Culturally appropriate career counseling model. Reprinted with permission from Fouad and Bingham (1995).

- Compare the effect of socioeconomic status (SES) on perceived supports and barriers.
- Determine if parental education had a significant effect on the differences in the perceptions of supports and barriers.

Thus, research questions for the current study include the following:

- Research Question 1: What differences are observed on measures on supports and barriers between sexes?
- Research Question 2: Is there a differential impact of the intervention on measures of supports and barriers by sex?
- Research Question 3: What is the impact of socioeconomic status and parental education levels on measures of supports and barriers?

2. POSITIONALITY STATEMENT

It is important to note that all of the authors for the manuscript are women at various levels of education and life experiences. Two of the investigators are African American women who are products of low socioeconomic households in the rural south. Both are tenured faculty in the biology department. One received their doctorate degree from a predominantly White institution (PWI) and the other from a historically Black college and university (HBCU). One of the investigators, another author, is a cis-gender female, European American of Eastern European descent, who is a product of a lower middle class socioeconomic household in the urban north. She was educated in PWIs and has worked at HBCUs for over 20 years as of this writing. In addition, she is an experienced vocational psychology professional and faculty member who understands the divergence of resources and lack of literature that targets underserved and underrepresented populations. These three senior authors have worked at the current institution for over 17 years each and have observed the change in the motivation and attitudes of students over time, as well as a decline in enrollment, particularly in STEM areas. They have made long-term commitments to educating the distinct student population in an environment that is unique for an HBCU. The two other investigators are White psychology graduate students whose first experiences at an HBCU have been at the current institution. Through their educational interests and socialization in the psychology program, they have come to understand the power and advantages of privilege that the majority of students at an HBCU do not enjoy. The experiences and interests of the mixed group of authors has driven the desire to attempt to understand the limitations and contextual factors that influence the success and retention of undergraduate and underprivileged STEM students, the external factors and lived experiences our students bring with them to college, and how these factors affect their academic success and persistence. Furthermore, authors attempt to understand the students' awareness of the limiting factors that negatively affect their perspective and academic socialization skills.

3. PROTECTION OF VULNERABLE POPULATIONS

The results of this study are coded, and participants' identities are not physically attached to the collected information. Identifying data will be destroyed when no longer needed, per American Psychological Association (APA) guidelines.

4. METHOD

4.1 Participants

The current study included 208 underrepresented minority undergraduate students (N = 79.6% African American) enrolled in STEM fields at an HBCU. The sample (Table 1) consisted predominantly of first-year students (32.6% first years, 18.0% sophomores, 23.2% juniors, 20.9% seniors, and < 5.0% fifth-year seniors or beyond) whose ages ranged from 18 to 53 years old (m = 21.43, sd = 4.711). Over half of the sample identified themselves as female (68.7%; N = 145), and 28.9% identified themselves as male. The majority of the sample indicated parental education as obtaining less than a baccalaureate degree (63.3% of fathers; 56.6% of mothers). Regarding socioeconomic status, 47.9% (N = 101) of participants identified as middle class, 29.0% identified with lower or lower middle class, 16.6% identified as upper or upper middle class, and 6.7% declined to report. Eighty-one students completed all parts of the study, allowing for 81 matched pairs to be analyzed; 56 of whom were exposed to the intervention.

4.2 Measures

Participants in the present study completed a demographic questionnaire and the STEM Contextual Supports and Barriers Scale (SCSBS) (Lent et al., 2003) and the STEM Environmental Supports and Barriers Scale (SESBS) (Lent et al., 2005) as a part of a larger study.

4.2.1 STEM Social Supports and Barriers Scale (SSSBS)

The STEM Contextual Supports and Barriers Scale (SCSBS) (Lent et al., 2003) asked participants to indicate how likely they would be to experience the conditions described in each of the 15 supports (e.g., "get encouragement from your friends for pursuing this major") and 23 barriers (e.g., "feel pressure from parents or other important people to change your major to some other field"). A five-point Likert scale ranging from 1 (not at all likely) to 5 (extremely likely) was used to assess perceived environmental supports and barriers relative to pursuit of a STEM major. Lent et al.'s (2003) version of this scale yielded coefficient alphas of 0.932 for the support scale and 0.949 for the barrier scale. The internal reliability coefficient for the current sample was 0.949 for social barriers and 0.932 for social supports.

TABLE 1: Sample demographics

Demographics	Percentage	Number
Race/Ethnicity		
Black or African American	79.6%	168
Hispanic American	2.4%	5
White or European American	9.0%	19
Asian/Pacific Islander American	.9%	2
International/Immigrant	5.2%	11
Multicultural	2.4%	5
Year in School		
Freshman	32.6%	68
Sophomore	18.0%	38
Junior	23.2%	49
Senior	20.9%	44
Fifth year and beyond	< 5%	9
Gender		
Female	68.7%	145
Male	28.9%	61
Socioeconomic Status		
Low to lower middle	29.0%	62
Middle class	47.9%	101
Upper-middle to upper	16.6%	35
Declined to report	6.7%	13
Mother's Education Level		
Some H.S.	7.1%	15
H.S. graduate	15.2%	32
Post-H.S. vocational	4.3%	9
Some college	15.2%	32
Associate's degree	11.8%	25
Bachelor's degree	18.5%	39
Post-graduate degree	22.3%	47
Father's Education Level		
Some H.S.	9.5%	20
H.S. graduate	19.9%	42
Post-H.S. vocational	4.7%	10
Some college	19.4%	41
Associate's degree	5.2%	11
Bachelor's degree	22.3%	47
Post-graduate degree	11.8%	25

4.2.2 STEM Environmental Supports and Barriers Scale (SESBS)

Lent et al.'s (2005) SESBS is comprised of nine items, which assess social environmental supports and barriers. Participants were asked to indicate how much they were helped by four supports (e.g., "financial assistance") and hindered by five barriers (e.g., "financial concerns") during their first year as a STEM major. Responses were given using a five-point Likert scale ranging from 1 (not at all likely) to 5 (extremely likely). Lent et al. reported alpha values of 0.847 (supports) and 0.835 (barriers) for the SESBS.

4.3 Intervention

Two selection procedures were involved in the identification of participants. First, a cohort method was utilized, with sections of first- and second-year biology courses selected for inclusion in the study. Faculty teaching these courses were contacted and asked for permission to incorporate the interventions into their classes. Course coordinators were contacted to identify sections of the courses to be utilized as control groups. An alternative assignment was provided by the instructor for individuals who would prefer not to participate.

The intervention was implemented with students enrolled in the general biology courses.

These courses satisfy the general education science requirements for STEM majors (i.e., biology, chemistry, agricultural science, engineering). Eight sections of General Biology I and II were included in this study, with six sections receiving the intervention and two sections serving as controls. The average number of students in each section was 29 (m = 29). Sections receiving the control were randomly selected by the course coordinator, one of the authors, resulting in one section of General Biology I and one section of General Biology II as controls.

Graduate-level psychology majors trained in career development/vocational psychology facilitated the interventions, which were delivered as sixteen 30- to 45-minute sessions per class period for an accumulated total of eight hours. During this time, facilitators presented information to the students and engaged them in activities targeted at assisting in developing the skills needed to manage their careers in biology. The goals included helping students to (1) understand their reasons for choosing their major and career options for applying their knowledge; (2) understand the value of current learning experiences in laying the foundation for their career; (3) to apply their critical thinking and problem-solving skills to the tasks needed to select and apply for graduate school and employment; and (4) develop a workable 10-year plan for reaching their career goals. Sessions included career development topics such as "looking at the long term" and "work–life balance."

4.3.1 Intervention Model

The SCCT vocational career counseling theory is one of the more prolific examples and models utilized today, having formed the basis of over 200 published, peer-re-

viewed journal articles and even more presentations. It is the most recent model that explicitly incorporates attention to diversity in providing a model to understand the process of career development. In addition, it provides a model of factors that impact career development. Thus, along with literature on the effectiveness of career interventions (e.g., Brown and Krane, 2000; Brown et al., 2003), it provides guidance as to the most effective interventions to use in order to enhance individual's career development, as well as their skills in this area. Further, Hammond (2017) and Hammond et al. (2021) found that even students who had declared a major still experienced difficulties with career development activities. Finally, Fouad and Bingham's (1995) cultural model for effective career intervention is the most frequently cited process guidance for use with people of color in the vocational psychology literature. Thus, this process, particularly with attention to the incorporation of culturally appropriate role models (Brown and Krane, 2000; Brown et al., 2003). A search of the literature and of the NSF awards database found one study (Hammond, 2012–2015) that has attempted to develop/implement a STEM student-focused intervention that includes a culturally sensitive component, specifically to African Americans and those of low socioeconomic status.

5. FINDINGS

Data were screened for incomplete responding, outliers, and assumptions with satisfactory results. To facilitate analyses, change scores were created. *Post hoc* power analysis indicated that power was adequate to conduct analyses ($1\text{-}\beta = 0.906$ for repeated measures, with in-between interaction) (Faul et al., 2007).

5.1 Sex, Parental Education, and SES

5.1.1 Sex

An independent samples t-test was conducted to examine if differences on the measures of supports and barriers existed between groups based on sex. The analyses reveal that male biology students (N = 61) did not score significantly different from female biology students (N = 145) on measures of perceived supports ($m = 3.68$, $sd = 0.76$; $m = 3.73$, $sd = 0.78$, respectively) or barriers ($m = 2.35$, $sd = 0.91$; $m = 2.27$, $sd = 0.83$, respectively), $p > 0.05$. Thus, the analysis was conducted without regard to differences by sex.

5.1.2 SES

A one-way between-subjects ANOVA was conducted to compare the effect of socioeconomic status (SES) on perceived supports and barriers. SES was divided into three conditions: upper class, which consisted of students identifying as "upper-middle" or "upper" class, middle class, and lower class, which consisted of students identifying

as "lower-middle" or "lower" class. There was a significant effect of SES on perceived supports ($F_{(2, 195)} = 5.35$, $p < 0.005$) and environmental supports ($F_{(2, 191)} = 4.49$, $p < 0.05$, Table 2). *Post hoc* comparisons using a Bonferroni correction indicated that the mean score of perceived supports for students identifying as "lower class" ($m = 3.54$, $sd = 0.67$) was significantly different than those identifying as "upper" ($m = 3.99$, $sd = 0.84$) or "middle class" ($m = 3.86$, $sd = 0.74$). Similarly, *post hoc* comparisons using a Bonferroni correction (Table 3) indicated that the mean score of perceived environmental supports for students identifying as "lower class" ($m = 3.45$, $sd = 0.73$) was significantly different than those identifying as "upper" ($m = 3.92$, $sd = 0.88$) or "middle class" ($m = 3.81$, $sd = 0.91$). Significant differences did not occur for measures of barriers or environmental barriers.

5.1.3 Parental Education

A one-way between-subjects ANOVA was conducted to determine if there were significant differences in perceptions of supports and barriers depending on parental education levels. Significant differences regarding the effect of parental education on perceptions of supports and barriers were not found for individuals exposed to the treatment, $F_{(6, 103)} = 1.57$, $p > 0.05$. However, significant differences were observed for the effect of maternal education on perceptions of supports (Table 4) and barriers (Table 5)

TABLE 2: Between-subjects ANOVA: effect of SES on perceived and environmental supports

		Sum of squares	***df***	**Mean square**	***F***
Perceived supports	Between	5.79	2	2.897	5.35**
	Within	105.52	195	0.541	
	Total	111.31	197		
Environmental supports	Between	6.52	2	3.258	4.49*
	Within	138.70	191	0.726	
	Total	145.22	193	2.897	

*$p < 0.05$; **$p < 0.005$.

TABLE 3: Perceived supports means (*post hoc* analysis)

		Mean	***Standard Dev.***
Perceived supports	Upper class	3.99	0.84
	Middle class	3.86	0.73
	Lower class	3.54	0.67*
Environmental supports	Upper class	3.92	0.85
	Middle class	3.81	0.91
	Lower class	3.45	0.73

*Significantly lower than both upper and middle class.

TABLE 4: Between-subjects ANOVA: influence of parental education on perceptions of support

		Sum of squares	*df*	Mean square	*F*
Control	Father education	5.721	6	0.953	2.600*
	Mother education	11.255	6	1.876	5.115**
	Error	20.537	56	0.367	
	Total	41.161	90		
Treatment	Father education	3.583	6	0.597	0.969
	Mother education	1.829	6	0.305	0.495
	Error	44.385	72	0.616	
	Total	61.293	103		

*$p < 0.05$; **$p < 0.01$.

TABLE 5: Between-subjects ANOVA: influence of parental education on perceptions of barriers

		Sum of squares	*df*	Mean square	*F*
Control	Father education	7.512	6	1.252	2.554*
	Mother education	6.846	6	1.141	2.327*
	Error	27.455	56	.490	
	Total	59.660	90		
Treatment	Father education	6.729	6	1.121	1.571
	Mother education	4.265	6	0.711	0.996
	Error	50.684	71	0.714	
	Total	74.744	102		

*$p < 0.05$.

for individuals not exposed to the treatment (supports: $F_{(6, 72)} = 5.12$, $p < 0.001$, $r^2 = 0.35$; barriers: $F_{(6, 56)} = 2.33$, $p < 0.05$, $r^2 = 0.20$), as well as for paternal education (supports: $F_{(6, 72)} = 2.60$, $p < .05$, $r^2 = 0.22$; barriers: $F_{(6, 56)} = 2.55$, $p < 0.05$, $r^2 = 0.22$). However, *post hoc* analyses revealed that the differences were not significant after applying Bonferroni corrections.

5.2 Intervention Effectiveness

Paired samples t-tests were conducted to establish the efficacy of the intervention (Table 6). Data indicates that the scores of individuals who were not exposed to the intervention did not significantly differ across time for any of the measures (supports: $m = –0.12$, $t_{(25)} = –1.025$, $p > 0.05$; barriers: $m = 0.007$, $t_{(24)} = 0.039$, $p > 0.05$; environmental supports: $m = 0.087$, $t_{(25)} = 0.57$, $p > 0.05$; supports: $m = –0.092$, $t_{(25)} = –0.519$, $p > 0.05$). Individuals exposed to the intervention did not score significantly different on measures of environmental supports and environmental barriers ($t_{(52)} = 1.38$, $p > 0.05$; $t_{(52)} = –0.91$, p

TABLE 6: Descriptive statistics and t-test results for SCCT on perceptions of supports and barriers

		Pretest		Post-test			95% CI for mean difference			
	Outcome	**M**	***SD***	**M**	***SD***	**N**		***r***	***T***	***df***
Treatment	Supports	4.01	0.78	3.80	0.86	56	–0.01, 0.43	0.49**	1.897*	55
	Barriers	2.04	0.76	2.20	0.81	55	–0.32, –0.00	0.72**	–2.012*	54
	Env. supports	3.86	0.92	3.71	0.92	53	–0.07, 0.37	0.63**	1.381	52
	Env. barriers	1.73	0.83	1.87	0.92	53	–0.42, 0.16	0.28*	–0.908	52
Control	Supports	3.71	0.65	3.83	0.72	26	–0.36, 0.12	0.61**	–1.026	25
	Barriers	2.30	0.73	2.29	0.94	25	–0.38, 0.40	0.37	0.039	24
	Env. supports	3.70	0.65	3.59	0.90	26	–0.22, 0.40	0.54*	0.572	25
	Env. barriers	1.87	0.64	1.96	0.94	26	–0.46, 0.27	0.39*	–0.519	25

*$p < 0.05$; **$p < 0.001$.

> 0.05, respectively). However, scores significantly differed for individuals exposed to the intervention on measures of supports and barriers. Before the intervention, participants scored marginally significantly higher on the measure of perceived support (m = 4.01, sd = 0.78) than after the intervention (m = 3.79, sd = 0.85), $t_{(55)}$ = 1.90, p = 0.06. Dissimilarly, before the intervention, participants scored significantly lower on the measure of perceived barriers (m = 2.03, sd = 0.76) than after the intervention (m = 2.20, sd = 0.81), $t_{(54)}$ = –2.01, $p < 0.05$).

6. DISCUSSION

The present study explored the effect of a culturally appropriate SCCT intervention on students' perceptions of supports and barriers. Results suggest that the intervention affected student's perceptions of supports and barriers. After the intervention, STEM student awareness of supports and barriers increased and resulted in a decrease in perceptions of social support as compared to the control group. Furthermore, the intervention appears to mediate the influence that parental education has on the perceptions of supports and barriers. Significant differences were found between students identifying as low-middle or lower class when compared to those identified as upper or middle class in terms of perceived supports. In terms of gender, there was no significant difference between males and females in their perceptions of supports and barriers.

Of note, results indicated that there were significant differences in how individuals identifying as lower-middle or lower class identify STEM supports and environmental supports compared to those of higher SES. Furthermore, no significant difference was found between the groups on measures of barriers.

6.1 Socioeconomic Status

Previous studies had not examined the role of socioeconomic status on the impact of career-related interventions. Chan (2010) points out the lifelong impacts of the effects of socioeconomic status on women and people of color. Kerr et al. (2011) reported on the impact of this variable in the development of their measure of "distance from privilege." Thus, this variable is one that is just now beginning to be addressed due to limitations in measurement issues. The finding that students from families who fall into the lower socioeconomic status category are aware of the difference in supports and understand its impact on their current and future career trajectory is an important issue to address. One immediate method for minimizing the impact of this variable on students is for faculty members to begin considering the idea that true student abilities may be artificially depressed by the impact of the lack of resources. Providing opportunities for students to grow or "catch up" in these areas appears to be important in order for students to reach their full potential and persist in this challenging major.

6.2 Parental Education

Studies indicate that parents influence their children in many ways. This goes beyond what the parent thinks, but their actions and choices can also influence the child. In this study, the finding that parental education is related to student perceptions of supports and barriers in the control group is consistent with previous findings of parental influence on their children's career development (Krumboltz et al., 1982). Prior studies report that parents are a big influence on their children, especially in their development of perceptions and beliefs about the world. However, our study found no significant difference between the groups for students' perception of support and barriers as compared to parental education for the treatment group. This suggests that the intervention may moderate the effects of parental education.

6.3 Intervention Effectiveness

The results demonstrated the efficacy of the intervention in an unexpected way. While previous literature suggests that career interventions are beneficial for students and improves career development (Spokane, 1991; Hardesty, 1991), it does not examine how this occurs. Although these studies suggest that career development interventions are related to improvements in academic major/career choice (Halasz and Kempton, 1997), career decision-making skills (Savickas, 1990), and retention (Krause, 1998), they do not examine the effects on perceptions of supports and barriers. As career interventions have shown to be beneficial, an assumption can be made that once completed, perceptions of barriers would decrease, and perceptions of supports would increase. However, results from the present study suggest the opposite. Perceptions of barriers increased in the intervention group as students became aware of barriers that were previously unknown to them. Similarly, results suggest that students gained insight on the various supports that were available to them. The intervention did not increase supports nor reduce barriers but provided knowledge to students about their field of study and realistic expectations. Also, with increased awareness, participants gained the knowledge to seek out the supports and work in ways that counteract the barriers.

6.4 Limitations

This study is not without limitations. While the sample size was sufficient for conducting the independent samples t-test, when examining other factors impacting the students' perceptions of supports and barriers (i.e., SES and parental education), the low power influenced the results. Despite having low power (0.59), the one-way ANOVA indicated significant differences between groups based on the mother's education level. However, *post hoc* analyses did not find significant differences between groups. A larger sample size with more diversity in maternal education would help in establishing the impact of maternal education on student perceptions of supports and barriers.

Furthermore, while the results indicate significant differences between scores on measures of supports and barriers for African American students at an HBCU based on their exposure to a culturally competent career intervention, one must be cautious with generalizability. Students select their colleges and universities for various reasons; therefore, African American STEM students at an HBCU may differ from those who have selected to attend a PWI. Further research investigating these differences would be beneficial.

It is additionally important to consider how differences existing across STEM majors may impact generalizability—specifically differences in department culture and STEM identity development. The present study targeted STEM students taking biology classes, regardless of which STEM-related major they were pursuing. The intervention they received focused specifically on assisting students in developing the skills needed to manage careers in biology. Most skills included in the intervention were transferable across disciplines (i.e., critical thinking and problem-solving skills) as well as across different tasks within career development (e.g., developing a ten-year career plan, or applying for graduate school or a job); however, some were less so (i.e., biology-specific requirements for graduation and resources available at the department and university levels). Research suggests that some STEM departments have different cultures and structures that may impact student engagement or completion in the major; for example, some mathematics courses may serve an unintended function as gatekeeper, preventing students from pursuing the career trajectory (National Academies of Sciences, Engineering, and Medicine, 2016). Given research on differences existing across STEM students' identity development, including differences related to "in-depth exploration" and "reconsideration of commitment" across STEM disciplines (Kelly et al., 2020), future research should consider studying the differences between the efficacy of this intervention across STEM disciplines.

Finally, the sample size was limited for our study due to several unforeseen data collection issues. Although participants were surveyed before and after the intervention, researchers were unable to match all of the data due to participant entry error. Student data was matched using their student identification (ID) number, which was assigned to them by the university. This proved to be problematic because some students did not know or could not correctly recall their identification number, resulting in difficulties matching student's pre- and post-test data. Furthermore, not all control group data was gathered simultaneously with interventions. While control group members completed the survey at the beginning and end of the semester, not all students responded at both time periods. These students were, therefore, unable to be included in the paired samples t-test. Also, it should be noted that while the interventions were done with students enrolled in general biology courses, these courses satisfy the science requirement for general education. Thus, students who enroll tend to be STEM students with majors including biology, chemistry, agricultural science, and engineering.

7. CONCLUSIONS AND EDUCATIONAL IMPLICATIONS

Due to the high enrollment of African American students at HBCUs compared to the national average of 13% (NSF, 2016), our institution is an ideal environment to investigate

the issues surrounding the career choice, major field of study, persistence, and graduation of African American students in STEM. The ethnic composition of the university between Fall 2012–2016 was 69% African American, 20% White/Caucasian, and 11% Other (Hispanic, Asian, Pacific Islander, Native American, Non-Resident Alien, or Unknown); the average ACT composite score for incoming freshman is 18, which is below the 2018 national average (20.8) (American College Test, 2018), with an average high school GPA of 2.8/4.0. These numbers indicate that a significant population of our students originates from areas or backgrounds in which they may not have received adequate academic preparation and/or counseling for higher education. Therefore, the six-year graduation rate is approximately 40%, compared to the national average of 59% for public institutions (Kena, 2016). Interestingly, from 2013 to 2016, 37.5% of the institutional total enrollment were students aged 25 and older. According to a National Student Clearinghouse Research Center report (2017), retention and persistence remains lowest for African American students in comparison to other ethnic groups. Furthermore, retention and persistence for first-year students over the age of 24 is lower than other age groups. The 2016 NSF data reports that African Americans represent only 9.01% of graduates across the sciences (NSF, 2016). These statistics indicate the urgency to address the culturally specific needs of students at HBCUs and other MSIs that may not exist at PWIs. As previously mentioned, there is a need to understand not only the social and cultural differences that are idiosyncratic to the African American student but also to examine the role of the students' perception of supports and barriers in relation to these idiosyncrasies that have been shown to contribute to their success or lack thereof. To better determine the effects of the culturally competent SCCT intervention on students' perceptions of supports and barriers, future research should include other HBCUs and predominately White institutions (PWIs). This would allow for further comparison of the intervention on minority students in various learning environments.

This study supports the role of psychological intervention in closing the gap between students from diverse income levels and parental households. The results of this study lay the framework for understanding and addressing the litany of issues beyond academics that affect specific student from distinct backgrounds. It supports the importance of a more exhaustive investigation of integrating early career intervention into the undergraduate curriculum as a practice that has the potential to improve retention and persistence.

ACKNOWLEDGMENT

This work was supported by the National Science Foundation under Grant No. 1238778.

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