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AFRICAN AMERICAN MALES' ATTITUDES TOWARD THE SCIENTIFIC WORKFORCE: IMPLICATIONS FOR EDUCATIONAL AND OCCUPATIONAL DECISION MAKING TOWARD STEM

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The underrepresentation of African American males in STEM fields has serious implications for the economic vitality of the United States, especially since the predominant demographic among STEM workers (White, non-Hispanic men) is shrinking as a proportion of the overall U.S. population. Although this complex topic has been highly researched, there have been few significant improvements in engaging African American males in the STEM pipeline. Using the state of Arizona as a microcosm of national trends and social cognitive career theory (SCCT) as a frame for analysis, this study explored the following two research questions: (a) Do attitudes toward STEM fields among African American males in the state of Arizona influence their decisions to pursue college degrees and careers in these fields after controlling for other personal characteristics?; and (b) What are the significant factors that lead students to pursue STEM majors and careers in the state of Arizona? The findings point to SCCT as a useful heuristic for understanding the complexity of STEM major and career decision making for African American men. Evidence suggests that each of the components of SCCT—personal attributes, external environmental factors, and overt behavior—are all at play in African American male Arizonans' decisions to pursue STEM majors in college and/or STEM careers. These findings may contribute to the development of new and improved interventions and best practices aimed at increasing the number of African American men in STEM majors and careers.

KEY WORDS: *African American, males, STEM, occupational decision making*

1. INTRODUCTION

In recent years, leaders in the U.S. and worldwide have voiced concern about their respective country's science, technology, engineering, and math (STEM) workforces, with some enacting policies aimed at bolstering the training and skillsets of their citizens (National Science Board, 2021; Varma and Frehill, 2010). In the U.S., researchers have highlighted the underrepresentation of Black men in STEM fields in particular as deserving considerable attention and resources (Strayhorn, 2015; Charleston, 2012). However, explaining the reasons for this underrepresentation requires understanding the antecedent variables contributing to Black men's choice to major in a STEM field in college or to pursue a STEM career path—decisions which may vary on a global, or even national, scale. This study examines data from the state of Arizona in an effort to elucidate some of the antecedent variables that structure the choices and frame the pathways to STEM degrees and majors among Black men. More specifically, this study explored the following two research questions: (a) Do attitudes toward STEM fields among African American males in the state of Arizona influence their decisions to pursue college degrees and careers in these fields after controlling for other personal characteristics?; and (b) What are the significant factors that lead students to pursue STEM majors and careers in the state of Arizona?

2. PERSISTENT UNDERREPRESENTATION IN STEM FIELDS

Historically, throughout the pipeline, African American males often attend and underachieve at schools in failing education systems, which further limits their likelihood of pursuing more challenging and prestigious careers (Moore, 2006; Oguntoyinbo, 2013; Strayhorn, 2015; Museus et al., 2011). For students of color, lack of early exposure to engaging math and science education may contribute to their underrepresentation in STEM fields (Museus et al., 2011; Varma, 2006; Strayhorn, 2015). Furthermore, teachers and counselors often discourage African American males from pursuing careers in STEM, causing them to subsequently eliminate such options as viable (Moore, 2006). Socioeconomic status also plays an important role in ethnic minority persistence in STEM since it often determines the quality of elementary and secondary education a student receives as well as the student's ability to pay for college (American Council on Education, 2006; Museus et al., 2011). Additionally, African American students are less likely to be raised by parents who themselves attended college, making the pursuit of higher education, a requirement for most STEM careers, an unfamiliar endeavor (American Council on Education, 2006). People of color are also underrepresented as math and science educators, which Gibson (2007) argues may be consequential in that minority students are less likely to have STEM role models.

In STEM fields, African American males tend to have persistence rates below the average overall academic persistence rates for their ethnic group (Cabell, 2021; American Council on Education, 2006; Williamson, 2010). Additionally, Black males who attend college tend not to study STEM subjects (Riegle-Crumb and King, 2010; Williamson, 2010). A 2012 report found that of highly involved, high-achieving Black male undergraduates with grade point averages above 3.0, only 23.3% were STEM majors. Since 2000, the proportion of underrepresented minorities in engineering and physical sciences has remained flat, while participation in mathematics has dropped (National Science Foundation, 2015).

In a qualitative study conducted by Moore (2006), several recurring themes emerged over the course of 42 in-depth interviews with African American male college students pursuing engineering majors. Participants indicated that their success in STEM careers was a function of their prior interest in STEM subjects, familial encouragement and support, aptitude in math and science, meaningful academic experiences and relationships prior to college, and meaningful opportunities that further bolstered students' confidence to enter the STEM field.

Similarly, a study of three undergraduate institutions that are particularly proficient at generating ethnic minority student success in the STEM fields found that these colleges encouraged a campus culture of strong networking values, a belief in humanizing the educational experience, a commitment to targeted support, and an assumed institutional responsibility for racial/ethnic minority student success. Additionally, these schools took a holistic approach to sustaining these cultural elements, which further bolsters minorities' sense of belonging in their educational activities (Museus and Liverman, 2010). A study by Williamson (2010) supports these findings with regard to the importance of campus climate in encouraging Black males' motivation and commitment to pursuing their STEM studies at the college level. However, this study also notes that the lack of Black male STEM professors discourages Black male STEM students from actively interacting with faculty outside of the classroom. Moreover, Oguntoyinbo (2013) proposes that the lack of faculty of color may be because the hiring processes often favor graduates of elite programs; many Black STEM scholars graduate from historically Black colleges and universities (HBCUs), which are often regarded as less prestigious than other STEM programs. The ability to pay for higher education also tends to disproportionately impact people of color compared to their White counterparts, making them more likely to hold jobs while enrolled in college, which may negatively impact their studies (Museus et al., 2011).

2.1 Historically Black Colleges and Universities (HBCUs)

HBCUs are an important degree-granting institution for many future Black scientists and engineers (Jett, 2013; National Science Foundation, 2015); however, the percentage of Blacks earning science and engineering bachelor's degrees from HBCUs has declined over time (National Science Foundation, 2015). Palmer et al. (2010) investigated specific initiatives aimed at increasing STEM participation at HBCUs and found that successes could be traced to an ability to integrate student and academic affairs in their approaches. A qualitative investigation of Black males studying math at HBCUs found that these students described these institutions as supportive racial environments, making them feel more supported academically and comfortable with their peers, which was conducive for their mathematics studies (Jett, 2013).

2.2 Predominantly White Institutions (PWIs)

Williamson (2010) and Lempinen (2005) argue that the traditional higher education model tends not to favor Black males socially, culturally, or financially. Williamson (2010) found that there may be differences within Black ethnicities when it comes to

STEM education at PWIs and that these differences may be the result of variation in familial influence and academic integration. For example, African males majoring in STEM-related subjects were most satisfied with their academic and intellectual development, followed by West Indian males, followed by African American males, then biracial male students. Differences between males within Black ethnic groups were also found regarding satisfaction with grade performance and interactions with faculty. Additionally, Williamson found that the Black male students at one PWI tended not to interact with each other, perpetuating a sense of distance from one another, which may negatively impact academic integration.

The existing literature implies that efforts to increase the participation of African American males in STEM require the collaboration of teachers, counselors, and families to encourage and support these students in their endeavors (Jackson et al., 2012; Moore, 2006; Varma, 2006; Strayhorn, 2015; Cabell, 2021). Additionally, there is a lack of solution-based research regarding the improvement of the education of Black males (Lee and Ransom, 2010). The American Association for the Advancement of Science Directorate for Education and Human Resources Programs identified three research priorities for raising participation of underrepresented minorities in STEM: (a) improve methodology, (b) improve research linkages, and (c) explore new research areas (George et al., 2001).

3. HISTORICAL CONTEXT: ARIZONA SCIENTIFIC WORKFORCE

This study addresses how attitudes toward STEM fields influence educational attainment and career choices among African American males using data from Arizona. To argue the appropriateness of our sample, we will discuss the ways in which the conditions in Arizona support the significance of this study. In particular, we examine levels of horizontal segregation in the major fields of undergraduate study in higher education and the workplace in terms of gender as well as race and ethnicity. Women and minorities are less likely to choose the STEM track through higher education and future careers across the world. On this point, the necessity of exploring the Arizona scientific workforce will be described based on the appropriate statistics in the following subsections.

3.1 Horizontal Segregation across Gender

By a wide margin, men still outnumber women in most STEM fields with regard to both higher education and labor force participation across the world, despite recent progress. For historical context, just 15.5% and 18.9% of students at Australian higher education institutions in the fields of engineering and information technology, respectively, were women in 2003. Comparatively, 72.9% and 74.0% of students in the fields of health and education, respectively, were women (Carrington and Pratt, 2003). Barone (2011) estimated overall levels of gender segregation in higher education using the Kappa indices of the uniform difference model in eight European countries, demonstrating considerable evidence of gender disparities across major fields of study: Italy (0.50), Austria (0.53), Germany (0.46), Netherlands (0.47), Finland (0.50), Norway (0.45), Czech Republic (0.42), and Spain (0.40).

Horizontal segregation by gender is also evident in the workplace. In Australia in 2009, women constituted only 22.3% of full-time professionals in the fields of design, engineering science, and transport. In 2011, around 13% and 27% of engineers and computer professionals, respectively, were women, much lower than the approximately 61% of social scientists who were women (Bell, 2010). A similar phenomenon was shown in the EU-27,* where women in STEM fields have remained a minority, accounting for approximately 32% of scientists and engineers in 2010 (European Commission, 2013). In the United Kingdom, women were more likely to work in personal services (84%), administration and secretarial works (78%), and sales and customer services (71%) in 2001 (Borchers and Gershwin, 2012).

3.2 Horizontal Segregation across Race and Ethnicity

Similar forms of segregation by race and ethnicity can also be observed across the world. For instance, in South Africa in 2001, more privileged jobs as technicians and professionals were held by Whites (37.69%) and Asian Indians (26.81%) than Africans (14.17%), although Africans comprised 79.0% of the population, and Whites were just 9.6% (Parashar, 2008). A similar racial and ethnic segregation in the labor markets was observed in Brazil as well. Non-White workers were overwhelmingly employed in agricultural sectors rather than STEM fields (Salardi, 2012). Likewise, the labor force segregation by race and ethnicity is commonly found in the whole world; however, only a handful of studies have examined the racial skew specifically with respect to STEM fields. This study will contribute to the related literature on gender, race, and ethnicity differences in choice of college major and occupation by analyzing Arizona's scientific workforce. In the next section, the demographic distribution in Arizona will be contextualized based on statistical arguments.

3.3 Relevant Conditions of the State of Arizona

Arizona is located in the southwestern region of the United States. The state is comprised of fifteen counties and bounded by California, Colorado, Nevada, New Mexico, and Utah. Manufacturing, mining, and tourism are the most prominent industries. According to the Bureau of Labor Statistics (BLS, 2014), the unemployment rate in Arizona was 8.0%, which was slightly higher than the national average of 7.4% in 2013. The average weekly wage was $877, somewhat lower than the national average of $920 in the second quarter of 2013. Consequently, the median household income in

* The EU-27 is composed of Austria (AT), Belgium (BE), Bulgaria (BG), Cyprus (CY), Denmark (DK), Czech Republic (CZ), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (EL), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE), and United Kingdom (UK).

2008–2012 was $50,256, around $3,000 less than the national average. Likewise, the state exhibited a higher percentage of persons below the poverty line in 2008–2012 (17.2%) than the national average (14.9%) as well as a union membership rate (5.0%) well below the national average (11.3%) (Census Bureau, 2014). The main variables in our analysis are demographic factors such as gender, race, and ethnicity as well as local labor market contexts such as the distribution of STEM occupations in Arizona. The environmental relevance of this study will be discussed by comparing the demographic and occupational distributions in Arizona to the overall distributions in the United States.

3.3.1 Distribution of Race and Ethnicity in Arizona

Arizona is the fifteenth most populous state in the United States. The total population of Arizona in 2013 was 6,626,624, which was approximately 2.1% of the total U.S. population. As seen in Table 1, Arizona has distributions in gender and educational attainment levels similar to the national average but with different features observable in its population distribution by race and ethnicity. Among Arizona residents, 84% are White, while only 4.6% are Black or African American, compared to 77.7% White and 13.2% Black or African American nationally. These demographic differences in race

TABLE 1: Demographic statistics, 2013 (reprinted from U.S. Census Bureau, 2014)

	Arizona	**U.S.**
Population	6,626,624	316,128,839
Gender (%)		
• Men	49.7	49.2
• Women	50.3	50.8
Race/ethnicity (%)		
• White alone	84.0	77.7
• Black or African American alone	4.6	13.2
• American Indian and Alaska Native alone	5.3	1.2
• Asian alone	3.2	5.3
• Native Hawaiian and Other Pacific Islander alone	0.3	0.2
• Two or more race	2.6	2.4
• Hispanic or Latino	30.3	17.1
• White alone, not Hispanic or Latino	57.7	62.6
Educational attainment level (%)		
• High school graduate or higher, percent of persons aged 25 and over, 2008–2012	85.4	85.7
• Bachelor's degree or higher, percent of persons aged 25 and over, 2008–2012	26.6	28.5

and ethnicity may further exacerbate racially divergent attitudes toward STEM fields and/or individual choice in educational attainment level and career choice. For example, the relatively small population of Blacks in Arizona may result in even fewer available African American male role models in STEM fields; thus, some caution is warranted in interpreting our findings.

3.3.2 Distribution of STEM Workers in Arizona

In 2012, 4.84% of those employed in Arizona worked in science and engineering fields, a marginally higher percentage than the national average (4.58%). Similar rates of science and engineering jobs as a percentage of all occupations can be observed in Arkansas, Connecticut, Michigan, Minnesota, and New Jersey (Fig. 1). Thus, these six states can be regarded as proper comparisons for investigating the STEM workforce.

More details on these features can be found in Table 2. In this study, we focus generally on STEM fields broadly as opposed to narrowly defined science and engineering fields in Arizona. Employment categories were divided into three groups: STEM, STEM-related, and non-STEM fields. Those employed in STEM fields (13.3% of the total number of employees in Arizona) refers to science, technology, engineering, and mathematics jobs, while STEM-related occupations (12% of the total) consist of architecture, healthcare practitioner jobs, and healthcare managers and technicians. Non-

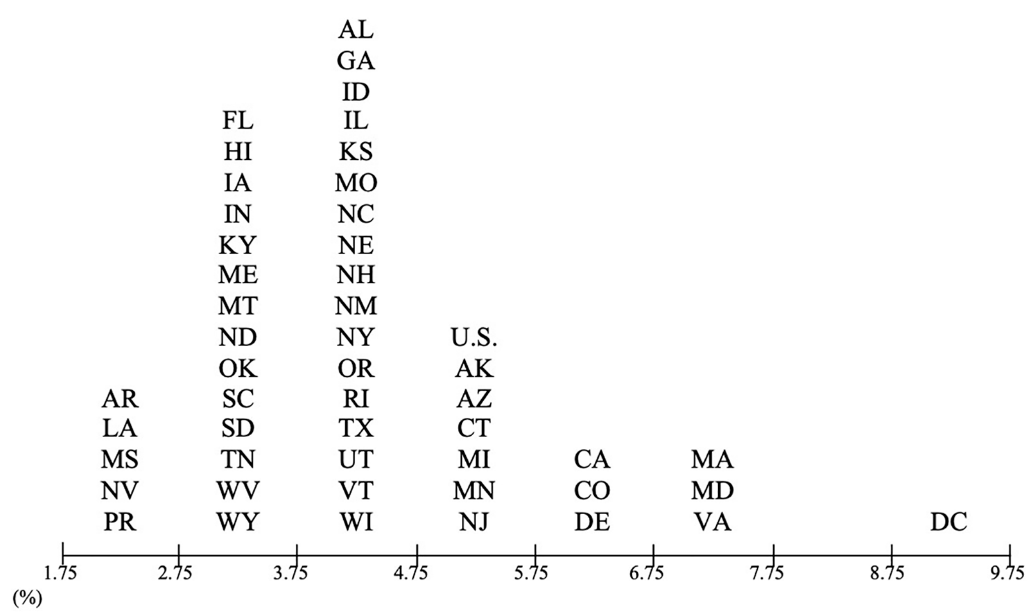

FIG. 1: Individuals in science and engineering occupations as a percentage of all occupations, 2012. Reprinted from National Science Board, National Science Foundation (2021).

TABLE 2: College graduate employment in STEM occupations, 2012 (reprinted from U.S. Census Bureau, 2014)

	U.S.	Arizona
Total	41,640,670	723,235
• Number	123,090	14,493
• MOE		
STEM		
• Number	5,171,415 (12.4%)	96,000 (13.3%)
• MOE	40,408 (0.1%)	4,918 (0.7%)
STEM-Related		
• Number	4,709,315 (11.3%)	86,595 (12.0%)
• MOE	31,862 (0.1%)	4,376 (0.6%)
Non-STEM		
Number	31,759,940 (76.3%)	540,635 (74.8%)
MOE	99,665 (0.1%)	13,520 (0.9%)

Notes: Civilian employed aged 25 to 64 with a bachelor's degree or higher educational attainment level. MOE refers to the margin of error.

STEM occupations (the remaining 74.8%) included all other occupations of a total 723,235 employees in Arizona.

In particular, the historical trends of the occupational distribution in Arizona explain why this study is important and relevant. As seen in Fig. 2, the percentage of science and engineering occupations has tended to increase over the years in both Arizona and the United States. In Arizona, the percentage of science and engineering occupations to all occupations had declined from 2003 to 2006, but increased afterward up to 4.85%

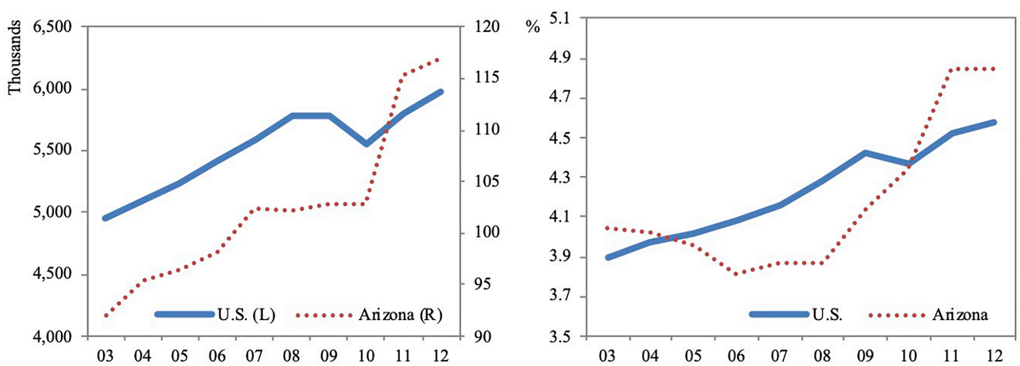

FIG. 2: Distribution of science and engineering occupations: levels (Left) and percentages (Right). Notes: L refers to the left axis, while R indicates to the right axis. Reprinted from U.S. Census Bureau (2014).

in 2011. In contrast, a sudden drop was observed nationwide in 2010, and the levels of increases were much smaller than ones in Arizona between 2010 and 2012. This evidence supports the significance of this study in examining Black males' attitudes toward STEM-based careers when the demand for scientific workforce skills has significantly increased over the national average in less diverse society. If Black males still pursue non-STEM career paths despite the overall increases of scientific workplace participation, research on explanation of their behaviors needs to be implemented.

4. THEORETICAL FRAMEWORK

The roots of social cognitive career theory (SCCT) are traced to Albert Bandura's (1986) social cognitive theory (SCT), which holds that human action is the result of both social context and "self-referent thought" (Lent et al., 2002, p. 258). Principally, SSCT is a heuristic framework for understanding career choice decisions. The actions taken by individuals in the pursuit of their chosen career path can be observed and analyzed through a series of three, bidirectionally interrelated concepts, namely: (1) *personal attributes*, (2) *external environmental factors*, and (3) *overt behavior* (Lent et al., 2002, p. 261). In the following section, each of the prior three SSCT variables are explicated in more detail.

4.1 Personal Attributes

In their development of SSCT, Lent et al. (2000) delineated a "triadic causal system" (p. 261), encompassing the *personal attributes* at play within the theory. Taken from Bandura's (1986) social cognitive theory, *personal attributes* are comprised of: (a) self-efficacy, (b) outcome expectations, and (c) personal goals (Lent et al., 2000, p. 261). First, developing (or losing) confidence in one's own self-efficacy is "acquired and modified via four primary sources of information (or types of learning experience): (1) personal performance and accomplishments, (2) vicarious learning, (3) social persuasion, and (4) physiological and affective states" (Lent et al., 2000, p. 262). In effect, individuals' positive self-efficacy beliefs result from a complex interplay of experiences. Successes in a given area (*personal performance and success*) promote self-efficacy beliefs, as does *vicarious learning*, or observing and learning from others' behaviors and actions. Individuals may also be influenced verbally through *social persuasion*, or affirmation of an individual's capacity to succeed, as well as physically through positive psychological and physical feedback (e.g., fostering positive moods) known as *physiological and affective states* (Bandura, 1997, p. 3–5). Conversely, an individual's confidence in his or her own self-efficacy may be diminished due to negative feedback, experiences of failure or rejection, an absence of visible role models or mentors, or the deployment of negative physical or psychological stimuli.

Second, outcome expectations are derived from beliefs associated with the consequences of particular actions and the positive or negative motivations associated with taking those actions or not. Outcome expectations are generally associated with individuals' evaluations of their own abilities in the face of perceived threats, as well as beliefs associated with accrual of action-contingent extrinsic and intrinsic rewards (Lent et al., 2000). As a derivative of one's self-efficacy beliefs, high or low expectations of the values associated with probable outcomes are largely contingent upon the complex calculus of the variables associated with self-efficacy (Bandura, 1997).

The third and final *personal attributes* component of SSCT concerns the goals individuals associate with particular courses of action (Lent et al., 2000). Such goals are "a critical mechanism through which people exercise personal agency or self-empowerment" (Lent et al., 2000, p. 263). Setting and maintaining goals are critical for sustaining individuals in their pursuit of desired outcomes.

4.2 External Environmental Factors

As Lent and colleagues (2000) emphasized, "social cognitive variables do not arise in a vacuum, nor do they function alone in shaping interest or other vocational outcomes" (p. 267–268). Indeed, the personal attributes that influence career choices are themselves rooted in social constructs and experiences encountering certain careers. Lent and associates (2000) presented the particularly apt example of gender bias associated with career choice. Hackett and Betz (1981), for example, demonstrated that gendered social values and expectations have historically cultivated strong self-efficacy beliefs among women and girls with respect to feminized careers and work (e.g., "caring professions" such as teaching and housework) but weaker self-efficacy beliefs toward traditionally "masculine" professions and careers (e.g., mathematics and engineering). Among the numerous external environmental factors cited in the SCT and SCCT literatures are schools and other academic institutions. Conceptualized as an "imposed environment," schools are comprised of "certain physical and sociostructural conditions [which] are thrust on people whether they like it or not," (Bussey and Bandura, 1999, p. 685). Bussey and Bandura (1999) further stress that "although [individuals] have little control over [their school's] presence, [individuals] have leeway in how they construe it and react to it" (p. 685). While external environmental factors such as gendered career expectations and constrictive social environments such as schools may negatively impact career choice decision making, personal agency (as mediated by self-efficacy beliefs) through which individuals are able to "construe" and "react" to their environments remains an important counterforce.

4.3 Overt Behavior

The third and final component of SCCT and SCT, *overt behavior*, is the most straightforward aspect of the theory. Overt behaviors are understood to be the "by-product" of the interaction of *personal attributes* and *external environmental factors* (Lent et al., 1994, p. 82). Bandura argued that through overt behaviors, individuals may "influence the situations that, in turn, affect their thoughts, affect, and [subsequent] behavior" (as cited in Lent et al., 1994, p. 82).

4.4 Gender, Race, SCCT, and STEM Careers

SCCT provides a particularly useful heuristic for understanding individuals' choice of STEM careers, and specifically for understanding the interplay of race and gender in STEM career choices and antecedents (e.g., Alliman-Brissett and Turner, 2010; Hackett and Byars, 1996; Lent et al., 2001, 2003, 2005, 2008, 2011, 2013; Lewis et al., 2011; Navarro et al., 2007). Considerations of sociocultural identities including, among others, race and gender, have become an emergent focus area within the study of career choice and development (Lent et al., 2000).

4.4.1 Gender

Scholars of career choice argue that girls and boys are socialized to conform to gender-appropriate behaviors and are ultimately guided toward socially acceptable careers (Arbona, 2000; Eccles, 1994). Socially sanctioned gender-appropriate behaviors and attitudes are reinforced through caregivers, teachers, and peers, orienting and directing children's career choices as they enter adulthood (Lent et al., 2000). Research concerning gender nontraditional career choices for women (e.g., STEM careers among high school girls) demonstrated support for SCCT, particularly the importance of strong self-efficacy as a predictor of young women's choice of a STEM career or academic major (Nauta and Epperson, 2003). In another study measuring women's persistence in engineering majors, Schaefers et al. (1997) found that SCCT variables, such as ability, support, and other barriers, as well as interest congruence were strongly predictive. Moreover, the statistical analysis of the Schaefers et al. (1997) model suggests that ability, self-efficacy, interest congruence, and the presence of supportive and encouraging social environments are strongly correlated with persistence in engineering across gender (p. 180). These findings help to contextualize the impact of gender in career choice decision-making processes. Often, discussion of gender as a variable in career choice is considered only with respect to women; findings such as those in Schaefers et al. (1997) demonstrate that the same underlying factors governing persistence may apply to men and women, at least in engineering.

4.4.2 Race

Grounded in an understanding of and sensitivity to the historical and cultural roots of racism and ethnocentrism in the United States, particularly related to educational and vocational issues, scholars employing SCCT have come to consider differences faced by racial minorities as an important factor in career choice (Hackett and Byars, 1996). In delineating SCCT, Lent and his colleagues (2000) noted that components such as self-efficacy and outcome expectations may be influenced early in life by, among other factors, familial structure; access to social, cultural, and economic capitals; and personal identity such as gender, race, and ethnicity. Furthermore, these factors contribute to socially constructed and defined opportunities, support mechanisms, or barriers (Hackett and Byars, 1996; Lent et al., 2000). Other researchers have demonstrated mediating effects of race and ethnicity on the components of SCT and SCCT, noting that self-efficacy, the core component of both theoretical frameworks, may be most impacted by racial and ethnic discrimination (Hackett and Byars, 1996).

Alliman-Brissett and Turner's (2010) research on African American adolescents in middle school showed that perceived racism, chiefly interpersonal and institutional racism, negatively impacts students' self-efficacy, outcome expectations, and interests pertaining to mathematics. These findings largely mapped onto conclusions drawn from prior research. In addition to the conclusions drawn between perceived racism and SCCT, Alliman-Brissett and Turner (2010) also found evidence bolstering prior findings (e.g., Bleeker and Jacobs, 2004; Turner et al., 2004) that underscored the importance of familial support, particularly that of mothers. Within the context of STEM careers and career-antecedent majors in college, Lent and associates (2003) found that external factors such as supportive relationships were an important factor contributing to student persistence in engineering. These findings found further support in Lent and associates' (2005) research on engineering students at three historically Black universities. Later, Lent and colleagues (2013) found that persistence among racial and ethnic minority students in engineering majors was largely attributable to environmental satisfaction, comprised of the components of SCCT. In sum, this body of SCCT literature suggests that perceived racism and ethnocentrism moderates racial and ethnic minorities' STEM career aspirations; moreover, the presence of strong social support structures contributes positively to both men and women's persistence in career-antecedent preparations and ultimately toward success in achieving STEM career-related goals.

Notable among the studies employing SCCT frameworks is that research is primarily conducted using school-aged and college student, pre-career samples. That is, heretofore researchers have not examined the perceptions, recollections, and experiences of working adults to determine which components of SCCT they might identify as being most salient to their career persistence. This research attempts to fill this gap.

5. DATA AND METHOD

In an effort to understand differences among African American males with regard to attitudes toward STEM-related majors and careers, logistic regression analysis was performed using data from a statewide survey of African Americans in Arizona. The dataset, variables, and analytic procedures are described in the proceeding section.

5.1 Dataset

Participants in this study were drawn from a larger project: the State of Black Arizona STEM Attitudes Survey (SBASAS), a statewide investigation of how African American Arizonans' attitudes toward STEM majors and careers influenced their presence in the scientific workforce. A broad-based convenience sampling procedure was used to collect these survey data between June and July 2011. The research team attempted to contact as many African Americans in the state as possible, recruiting respondents at 24 churches, two community events and meetings, and on five community listservs in Phoenix, Flagstaff, and Tucson. This multipronged approach resulted in 634 completed surveys; however, for this study 261 participants qualified for inclusion. Among these respondents, 61.7% were female, and 38.3% were male (see Table 3), with an average age of 48 years. Respondents were somewhat more likely to report having at least one child (73.8%) than the population as a whole. Lastly, only 27.1% of the individuals had majored in a STEM field.

5.2 Data Analysis

In an attempt to understand the relationship between differences in attitudes toward STEM-related majors and employment among African American males and their likelihood of pursuing such degrees and careers, logistic regression analysis was performed using data from the statewide survey. In particular, this analysis was used to model the probability of an individual pursuing a STEM major and STEM career (Cabrera, 1994). Several measures of fit were used to judge the significance of each logistic regression model: chi-square of the model, pseudo R^2, and percent of cases predicted (PCPs). The chi-square test for significance indicates that the independent variables jointly as a group correlate with the dependent variable. At most, the pseudo R^2 represents the proportion of error variance explained by the independent variables compared to a null model. PCPs represent the percent of cases predicted by the model. PCPs less than 55% signifies that the model poorly fits the observed data (Cabrera, 1994). As a measure of the magnitude of effects, we also report delta-p, a calculation of the change in the probability of the dependent variable occurring due to a change in the factor variable. For example, a delta-p value of 0.045 indicates that a one-unit change in the predictor is associated with a 4.5 percentage point increase in the likelihood that a faculty member would become an academic leader.

TABLE 3: Descriptive results of background characteristics

Variable	Percent (%)
Age (mean)	48
Parental status (Yes)	74
Majored in STEM	27

5.2.1 Dependent Variables

Two dependent variables were constructed from the SBASAS survey data based on the questions “Did you pursue a STEM major in college?” and “Are you working in a STEM field?” Responses were coded to create binary indicator variables for each majoring in a STEM field in college and working in a STEM field.

5.2.2 Independent Variables

In selecting independent variables, decisions were guided after consulting a broad swath of published research on degree and occupational aspirations pertaining to STEM and African Americans (e.g., Lent et al., 1984; Maton and Hrabowski, 2004; Hackett, 1985; Charleston and Jackson, 2011). Because our primary hypothesis concerns the importance of attitudes toward STEM on degree and career aspirations, we determined it was most important to control for respondents’ background characteristics. Accordingly, the logistic regression models included 16 independent variables. These measures (see Table 3 above) included (a) age and (b) parental status. An additional 14 attitudinal measures were also included (see Table 4).

6. LIMITATIONS OF STUDY

There are several limitations of this study. First, the analyses were limited to those variables collected by the survey. While these data are a rich source of information about attitudes of African American males in Arizona toward STEM, information about background characteristics was limited. Second, it is unclear how representative these data are because there was no way to compare participants’ attitudes with those of individuals who did not participate. Likewise, because other studies have not focused as narrowly on the state of Arizona for data concerning attitudes toward STEM majors and fields, there is no pre-existing research from which to draw insights. Fourth, relying on participants to recall their attitudes while they were students presents further barriers to inference. Finally, although the results are specific to the state of Arizona, they may have implications for states with similar characteristics and demographics.

7. FINDINGS

This study examined the extent to which attitudes held by African American males in the state of Arizona toward STEM majors and careers influenced their inclusion in the scientific workforce of the state.

7.1 Logistic Regression Results

Table 5 reports the results of two separate logistic regression models of respondents’ self-reports of their decisions to pursue STEM degrees and careers, respectively. Each model reports the delta-p values for statistically significant variables. The columns display statis-

TABLE 4: Variable codes and descriptions

Code	Descriptions
Age	Age of respondent (continuous)
Parent	Whether respondent is a parent (no is default group)
Considered	Whether respondent considered selecting a major in STEM
Society	I think STEM is very important in our society
Interesting	I think STEM topics/subjects are interesting
Difficult	I think topics/subjects in STEM fields are difficult
Ability	I believe I would have the ability to get a degree in a STEM field if I chose to major in STEM
Assistance	I think I could easily get assistance from faculty and peer students if I chose a STEM major in college
Job opportunities	I think that majoring in STEM fields is associated with more job opportunities
High pay	I believe jobs in STEM fields are associated with high pay
Respected	I think people working in STEM fields are respected in our society
Self-development	I think I can get more opportunities for self-development/growth in STEM fields
Community	I think there are a lot of people majoring/working in STEM fields in my community
Family support	I believe that my family highly supports or once supported me to get a degree in a STEM field
Welcomed	I believe that African Americans are welcomed in STEM-based careers
Successful	I believe that African Americans can have successful careers in STEM-based fields

tically significant delta-p values, which illustrate the change in default probability† attributable to each variable, controlling for all others. Based on the three measures of the model fit, both the STEM major and STEM career models are excellent fits.

In the model explaining the likelihood of African American males majoring in a STEM field, the delta-p values indicated that there were four variables that were significant predictors of pursuing degrees in a STEM field. These included having previously considered selecting a STEM major, encountering opportunities for self-development in a STEM field, and family support for their STEM degree pursuit. In contrast, African American males who associated jobs in STEM fields with high pay were, perhaps counterintuitively, less likely to have majored in a STEM field. Several additional variables produced negative but statistically insignificant effects (see Appendix A).

† In the context of this study, variables were coded such that increases in probabilities correspond to an increased likelihood of deciding to pursue STEM degrees and majors.

TABLE 5: Logistic regression results for the decision to pursue STEM degrees and careers for African American males

Variable	STEM major	STEM career
Background characteristics		
Age		0.0056**
Parent		
Attitude variables		
Considered	0.2055****	0.1627****
Society		
Interesting		
Difficult		
Ability		0.1131**
Job opportunities		
High pay	–0.1128*	
Respected self-development	0.1086*	
Community		
Family support	0.1592***	0.1027**
Welcomed success		
Sample	261	261
P_o	0.2714	0.2367
Model X^2, df	95.025, 16***	94.339, 16***
Pseudo R^2	0.460	0.450
PCP	0.792	0.800

Delta-p statistics are shown only for those variables whose coefficients were significant: $*p < 0.10$, $**p < 0.05$, $***p < 0.01$, $****p < 0.001$.

Results for the STEM career model were similar, with the delta-p values indicating four variables significantly related to the probability that individuals ultimately pursued STEM careers. With respect to background characteristics, older respondents demonstrated an increased probability of having pursued a STEM career. Likewise, individuals who had at one time considered selecting a STEM major, felt they possessed the ability to complete a STEM degree, and believed that their family supported the pursuit of a STEM degree were also more likely to have pursued a STEM career. Several other variables were negatively associated with a negative career pursuit but not in a statistically significant manner (see Appendix B).

8. DISCUSSION

The present study examines African American males' *post hoc* attitudes concerning STEM careers. The present study's findings offer support for the SCCT framework and prior research study conclusions. Two variables in particular were both found to be positively related to the probability that Black men in Arizona selected a STEM major in college and ultimately a STEM career. The first, whether the respondent "considered a STEM major" in college, supports other empirical evidence suggesting that selecting a STEM major and being employed in a STEM career would be strongly correlated with earlier consideration of a STEM major in college. The significance of having previously considered a STEM major in college suggests that career planning and goal-setting behaviors—key components of the personal attributes component of SCCT—is vital to achieving a desired career outcome (Lent et al., 2000). Personal goal setting may also be of particular importance for African American men, whose encounters with interpersonal and institutional racism (Alliman-Brissett and Turner, 2010) suggests *a priori*, significant resistance or impediments to achieving career goals (Brown, 1995; Hackett and Byars, 1996).

"Family support," a second significant variable in both STEM models, echoes prior SCCT theory and research findings concerning the importance of familial and social support (Alliman-Brissett and Turner, 2010; Bleeker and Jacobs, 2004; Brown, 1995; Lent et al., 2005, 2008, 2011). Prior research in the higher education field has shown that "parental encouragement and support facilitated the transition into the academic and social realms of the institution, enhanced commitments to both the goal of college completion and the institution, and increased the likelihood to persist in college" (Cabrera et al., 1999, p. 152). This study demonstrates a similarly positive relationship between African American men choosing a STEM college major or career and family support for that choice. Moreover, this finding aligns with other research such as Moore (2006), which uncovered the positive role families play in supporting African American male collegians in STEM majors such as engineering.

As a type of social support, having a supportive family has been identified as a universally positive force in the context of careers, regardless of gender or race (Lent et al., 2000), and for African American women in particular (Pearson and Bieschke, 2001). Our findings augment previous understandings of the role of social support within the SCCT literature insofar as these findings alter the conception of social support to focus specifically on familial support. Prior research examined the role of familial support as it pertains to power-imbalanced parent–child relationships, which may be more salient among youth and adolescents than in adults, rather than equitable familial relationships such as those between partners and spouses. Further research is needed to disambiguate these supportive familial relationships by examining the salience of relationships predicated on equality (i.e., romantic partnerships) and the salience of parent–adult child relationships on careers.

Another finding congruent with prior research is the positive mediating effect perceptions play in major, career choice, and persistence. That self-development was identified as exerting a positive effect on selecting a STEM college major demonstrates both the *social persuasion* and *vicarious learning* components of SCCT. Perceiving that a STEM career might positively contribute to one's self-development may manifest via the extrinsic affirmation of others (*social persuasion*) and the inherent self-development associated with positive experiences with *vicarious learning*, as evidenced by, for example, the cultivation of a positive mentor–mentee relationship.

Our analysis of the STEM career regression results provides some modest (albeit statistically insignificant) evidence supporting the *external environmental factors* component of SCCT. Our findings demonstrate that perceptions of one's likelihood of receiving assistance from faculty and peers while in STEM college majors, perceptions of society's respect for those working in STEM fields, and perceptions that African Americans are welcomed in STEM careers were all negatively associated with the likelihood of pursuing a STEM career. That is, the likelihood of pursuing a career in a STEM field may be negatively related to the perception that faculty and peers were unlikely to offer assistance during college, the perception that their chosen career field is unwelcome, or that society at large does not respect those working in STEM careers. These results suggest that the social environments of colleges and universities matter, as do broader societal expectations and stereotypes on African American men's career decision-making processes.

9. IMPLICATIONS

The results of this study are relevant across institutions of higher education, as the evidence suggests that each of the components of SCCT—*personal attributes*, *external environmental factors*, and *overt behavior*—are all at play in African American male Arizonans' decisions to pursue STEM majors in college and/or STEM careers. Specifically, our findings suggest that policies and practices aimed at increasing African American men's participation in STEM college majors and career fields may be enhanced by incorporating and emphasizing other aspects of SCCT. These might include interventions aimed at increasing self-efficacy, addressing negative gender and racial stereotypes, and supporting behaviors and choices that cultivate the *personal attributes* and *external environmental factors* referenced in SCCT. The two variables that were positively associated with increasing African American men's probability of pursuing a STEM college major or career—having previously "considered a STEM major" and having positive expectations of "family support"—further suggest that interventions aimed at recruiting and publicizing opportunities to learn about STEM careers may be beneficial to both African American men and their families. The importance of such information and support encouraging African American male students to consider STEM majors and careers has been emphasized in other research, which found a correlation between early exposure and success in STEM, specifically with respect to math courses (Wang, 2013).

Another finding, that self-reported perceptions of ability to succeed in STEM majors was positively associated with the pursuit of a STEM career, suggests that interventions aimed at supporting the persistence of students majoring in STEM may increase their likelihood of finding a job related to their major. That is, supporting students to develop their talents and abilities, therefore increasing their confidence in their abilities, may encourage students to choose a STEM major and thus increase their chances of earning a STEM degree. Aiding African American male students to consider majoring in

STEM fields, combined with other recruitment interventions focusing on their families, could be part of a comprehensive approach to better integrate African American men into STEM fields. Such integration requires multiple approaches, given the complex social system comprising STEM fields (Estrada et al., 2011) including the development of many of the aspects of SCCT shown here to contribute positively to decisions to pursue STEM majors and careers.

Finally, the results of the present study suggest that familial support and prior consideration of a STEM major continue to exert a positive influence on the pursuit of a STEM career beyond college. These findings suggest that support from families continues to be important for African American men after they have chosen a college major, which suggests that such support may also be important for encouraging returning or continuing adult students to consider STEM majors. Increasing participation rates for African American men in the STEM workforce may require special attention to this population, and their needs may not always align with those of younger students.

In closing, though the present study focused specifically on the U.S. state of Arizona, the distribution of STEM careers and the rates of racial and ethnic horizontal segregation in STEM and non-STEM careers in Arizona are not dissimilar from other states in the U.S. and globally. The findings presented here point to SCCT as a useful heuristic for understanding the complexity of STEM major and career decision making for African American men. Furthermore, as the empirical evidence supports SCCT, which was developed to be broadly applicable across race, gender, and nationality, these findings may contribute to the development of new and improved interventions and best practices aimed at increasing the number of African American men in STEM majors and careers.

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APPENDIX A. LOGISTIC REGRESSION OUTPUT FOR THE DECISION TO PURSUE STEM DEGREES

	B	S.E.	Wald	df	Sig.	Exp(B)
Age	0.001	0.015	0.006	1	0.940	1.001
Parent	–0.302	0.460	0.432	1	0.511	0.739
Considered	0.895	0.200	20.105	1	0.000	2.447
Society	0.419	0.491	0.729	1	0.393	1.521
Interesting	0.259	0.408	0.403	1	0.525	1.296
Difficult	0.170	0.188	0.819	1	0.366	1.186
Ability	0.066	0.250	0.069	1	0.793	1.068
Assistance	–0.338	0.246	1.889	1	0.169	0.713
Job opportunities	0.285	0.338	0.709	1	0.400	1.330
High pay	–0.681	0.378	3.237	1	0.072	0.506
Respected	–0.246	0.295	0.694	1	0.405	0.782
Self-development	0.498	0.283	3.086	1	0.079	1.645
Community	0.052	0.188	0.076	1	0.783	1.053
Family support	0.708	0.253	7.833	1	0.005	2.029
Welcomed	–0.089	0.235	0.142	1	0.707	0.915
Success	0.064	0.331	0.037	1	0.847	1.066
Constant	–9.033	2.386	14.332	1	0.000	0.000

APPENDIX B. LOGISTIC REGRESSION OUTPUT FOR THE DECISION TO PURSUE STEM CAREERS

	B	S.E.	Wald	df	Sig.	Exp(B)
Age	0.031	0.015	4.063	1	0.044	1.031
Parent	0.008	0.448	0.000	1	0.985	1.008
Considered	0.763	0.189	16.215	1	0.000	2.144
Society	0.829	0.519	2.555	1	0.110	2.291
Interesting	0.089	0.399	0.050	1	0.824	1.093
Difficult	0.180	0.191	0.886	1	0.347	1.197
Ability	0.551	0.263	4.389	1	0.036	1.736
Assistance	–0.339	0.240	1.998	1	0.157	0.712
Job opportunities	–0.137	0.302	0.205	1	0.651	0.872
High pay	0.412	0.344	1.435	1	0.231	1.510
Respected	–0.457	0.297	2.371	1	0.124	0.633
Self-development	0.318	0.262	1.475	1	0.225	1.374
Community	0.062	0.184	0.112	1	0.738	1.064
Family support	0.505	0.241	4.380	1	0.036	1.657
Welcomed	–0.295	0.221	1.771	1	0.183	0.745
Success	0.370	0.334	1.221	1	0.269	1.447
Constant	–14.521	2.940	24.398	1	0.000	0.000