Diverse Pathways: Applying the SCCT Choice Model to Understand Gender and Racial/Ethnic Differences in STEM Entry

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Abstract

Without a better understanding of what contributes to racial/ethnic and gender underrepresentation in science, technology, engineering, and mathematics (STEM) fields, many U.S. citizens likely will not be able to take full advantage of the socioeconomic affordances of STEM occupations. Additionally, the increasingly diverse nation will have a STEM workforce shortage because of STEM underrepresentation. The current study employs structural equation modeling of the High School Longitudinal Study of 2009 data to test a social cognitive career theory (SCCT) explanation of choice of a STEM major within the high school-to-college continuum for six subgroups: African American female, African American male, Latina female, Latino male, White female, and White male. Using a slight adaptation of a six-variable version of the SCCT choice model, we find SCCT choice constructs, measured in high school, are differentially tenable in predicting STEM major choice goal (i.e., intent to declare a STEM major) in the first semester of college and STEM major choice action three years postsecondary.

Keywords: STEM, social cognitive career theory, race, gender

A Social Cognitive Career Perspective of Gender and Racial/Ethnic Differences in STEM Entry within the High School-to-College Continuum

1. Introduction

Science, technology, engineering, and mathematics (STEM) occupations remain important to U.S. national security and function as high-paying, fast-growing sources of innovation in the nation's technology- and healthcare-driven economy. Yet, as the nation becomes increasingly ethnically diverse, many U.S. citizens likely will not be able to take full advantage of the socioeconomic affordances of STEM occupations, and the nation will have a STEM workforce shortage because of STEM underrepresentation (Fayer et al., 2017; Melguizo & Wolniak, 2012; Noonan, 2017). STEM underrepresentation at the undergraduate level is characterized by African American, Latino/a/x, and female individuals obtaining lower shares of STEM degrees than the overall distribution of their racial/ethnic or gender group in the U.S. population (National Science Foundation [NSF], 2019a, 2019b). In comparison, White individuals are nearly proportionally represented in STEM degree attainment, and Asian Americans and males are overrepresented in STEM degree attainment (NSF, 2019a, 2019b). As such, racial/ethnic and gender STEM underrepresentation warrants continued attention in research.

Prior scholarship that addresses STEM underrepresentation generally falls within two major lines of inquiry (Fouad & Santana, 2017; Museus et al., 2011). The first line of inquiry pertains to STEM persistence—a student outcome necessary for degree attainment (Chen & Soldner, 2013; Maltese & Tai, 2011). The second line of inquiry is STEM entry, which corresponds to the choice of a STEM major (Riegle-Crumb & King, 2010; Fouad & Santana, 2017). In studies of STEM persistence, the research on gender and racial/ethnic difference is quite clear. If female students pursue STEM majors, they are just as likely to persist to STEM degree completion as male students after controlling for other factors such as academic preparation (Ma, 2011; Maltese & Tai, 2011; Riegle-Crumb et al., 2010, 2019). Regarding race/ethnicity, African American and Latino/a/x students pursuing STEM majors are more likely to switch out of a STEM major to a non-STEM major than their White peers, and pre-college academic preparation is a significant factor in their STEM persistence (Chen & Soldner, 2013; Riegle-Crumb et al., 2019). The STEM persistence research also shows the majority of switching out of a STEM major takes place in the first two years of college (Griffith, 2010) and choosing a major after the first year of college increases the likelihood that a student will not complete their STEM degree (Riegle-Crumb et al, 2019). Based on these findings about the relationship of choice of a STEM major to STEM persistence, the STEM entry line of inquiry of STEM underrepresentation deserves a considerable amount of attention in the immediate future. The current study joins the STEM entry line of inquiry into STEM underrepresentation by employing structural equation modeling using the High School Longitudinal Study of 2009 data to test a social cognitive career theory explanation of choice of a STEM major within the high school-to-college continuum for six subgroups: African American female, African American male, Latina female, Latino male, White female, and White male.

2. Theoretical Framework

The social cognitive career theory (SCCT) choice model, is a school-to-work expansion of Bandura's (1986) social cognitive theory that describes how students make and modify their career choice (Lent et al., 1994; Lent, 2013; Lent & Brown, 2006, Lent et al., 2003, 2018). According to the SCCT choice model, a postsecondary career choice is an "unfolding process with multiple influences" across three major events: (1) articulating a goal or plan to pursue a career, (2) acting upon the goal by declaring a college major related to the career choice or by enrolling in a career training program, (3) obtaining feedback about career options via performance in college coursework or a career training program (Lent, 2013, p. 123).

In explanation of how a high school student comes to make a postsecondary STEM career choice, the SCCT choice model posits that personal demographic and distal contextual factors shape a student's learning experiences that, in turn, affect their self-efficacy—beliefs about his or her ability to perform successfully in STEM tasks, outcome expectations—imaginations about future outcomes in a STEM career, and personal goals—aspirations for entering the STEM career. Self-efficacy, outcome expectations, and personal goals individually and reciprocally produce a student's career behaviors such as interests, choice goals, choice actions, and performance. As an individual succeeds or fails in the career choice he or she makes, feedback loops create new learning experiences that increase or decrease the self-efficacy, outcome expectations, and personal goals needed for further career action. Gender and race/ethnicity can influence how a student obtains these experiences because discrimination and stereotypes can bias who accesses opportunities necessary for STEM career development. Proximal contextual factors such as supports and barriers in an education environment can positively or negatively moderate a student’s STEM interests and goals that, in turn, may shape whether a student chooses a STEM major irrespective of race/ethnicity or gender (Lent, 2013).

A large quantity of SCCT-related research has accumulated enough to conduct systematic reviews and meta-analyses about the theory’s application to STEM entry (Flores et al., 2017; Fouad & Santana, 2017; Lent et al., 2018). As such, Robert Lent, a co-founder of the SCCT choice model, and his colleagues recently used 30 years of studies comprised of 196 independent samples of individuals from high school to graduate school to conduct the first-ever meta-analysis that included both STEM choice goals and STEM choice action in a test of the SCCT choice model (Lent et al., 2018). The researchers found the SCCT choice model described 43% of the variance in the STEM choice action for all the data in the meta-analysis (Lent et al., 2018). However, due to a limited number of studies available to predict the STEM choice action by groups, the researchers could not model STEM choice action by gender and race/ethnicity. They were able to evaluate the model's fit and path relationships for choice goal by gender (male vs. female) and race/ethnicity (White students vs. students of color). The researchers found the SCCT choice model described 52%, 42%, 44%, and 38% of the variance in the STEM choice goal in female students, male students, students of color, and White students, respectively. In all four samples, interest was the strongest predictor of the choice goal. The strongest predictor of interest was outcome expectation for both racial/ethnic groups, but the strongest predictor of interest in both genders was self-efficacy. Regarding environmental factors, supports and barriers were found to be negatively related in all groups. Additionally, supports were positively and significantly associated with self-efficacy, outcome expectation, and choice goals in all groups except for not significantly predicting the choice goal of students of color. Taken together, the meta-analysis statistically shows the SCCT choice model is tenable for describing STEM entry, and path relationships between SCCT constructs can differ by race/ethnicity and gender. Now, the field of education needs to understand more about differences in career development for STEM entry within and across gender and races/ethnicities.

3. Conceptual Perspective for the Present Study

The current study addresses this gap in the literature by employing structural equation modeling of the SCCT choice model for six gender and racial/ethnic subgroups from a sample within the High School Longitudinal Study of 2009. Figure 1 displays our model adapted from the SCCT choice model that Lent et al. (2018) used in their recent meta-analysis. There are three differences between our six-variable model and the six-variable model in the meta-analysis. First, we add the choice action as an outcome in the path analysis. Second, we exclude environmental barriers as a predictor in our model because the measure was not available in the dataset. Third, we use a choice goal during high school instead of an outcome expectation during high school.

Initially, we constructed the model with a choice goal during high school inadvertently defined as an outcome expectation during high school. When we realized this measure was best defined as a choice goal during high school, we could not return to the respective university campus where the restricted data is housed due to the pandemic of 2020. Because we found the choice goal during high school—an 11th grade expectation for a STEM occupation at age 30—to be predictive of a student's STEM major choice goal in the first semester of college for all six subgroups and predictive of the STEM major choice action three years postsecondary for four subgroups, we believe our slightly modified SCCT choice model offers valuable information to the field of vocational psychology and educational research on STEM underrepresentation in the high school-to-college continuum.

Our model indicates that after controlling for student demographics and measures of prior learning experiences, a strong STEM self-efficacy during high school gives a student a more positive STEM career choice goal during high school. Both STEM self-efficacy during high school and a STEM career choice goal during high school help the student to develop a strong STEM interest during high school. That STEM interest during high school can translate into a STEM major choice goal at the beginning of college (i.e., intention to declare a STEM major in college). After this initial STEM major choice goal in college is actualized, the student takes an official STEM major choice action to pursue a course of study for a STEM degree. At the same time, STEM self-efficacy during high school and the STEM career choice goal during high school also directly influence the STEM major choice goal and STEM major choice action in college. As the student engages in this career decision-making process, environmental supports in the student's high school may encourage a student's STEM entry by influencing their social cognitive career attributes (Lent, 2013; Lent et al., 2008, 2018).

Among all the SCCT constructs, high school STEM supports are the most understudied topic regarding STEM underrepresentation (Fouad & Santana, 2017) although barriers such as stereotypes, discrimination, and school climates with low expectations mitigate student perceptions and resources for STEM preparation (Blickenstaff, 2005; Museus et al., 2011). For example, McWhirter et al., (2007) find Latino/a/x students perceive access to higher education to be more challenging than White students perceive access to higher education. Welton and Martinez (2013) demonstrate that some African American and Latino/a/x students within high poverty high schools perceive negative stereotypes and low expectations for their academic preparation in their school environment. Other scholars show barriers to postsecondary education, such as academic preparation, for Latino/a/x and African American students extend beyond student perception but systemically exist (Crisp et al., 2009; Rosenbloom & Way, 2004; Tyson & Roksa, 2016). To the extent that supports and barriers are negatively related (Lent et al., 2018), a school can mitigate systemic inequities in academic preparation and STEM career development through the following high school STEM supports: (a) employ teachers who are effective and encouraging (Fouad et al., 2010); (b) provide STEM afterschool programs (Dabney et al., 2012); (c) provide students STEM role models (Fouad et al., 2010; Fouad & Kantamneni, 2013); (d) afford students opportunities to participate in university-run STEM summer programs

(Kitchen et al., 2018); (e) increase a parent's awareness in STEM (Fouad et al., 2010; Kenny et al., 2007).

From this conceptual perspective, we investigate three research questions:

Research Question 1: To what extent does the SCCT choice model explain a student's STEM major choice goal in the first semester of college?

Research Question 2: To what extent does the SCCT choice model explain a student's STEM major choice action three years postsecondary?

Research Question 3: To what extent does the quantity of STEM supports available in a high school influence a student's STEM major choice action three years postsecondary?

We answer these questions for African American female, African American male, Latina female, Latino male, White female, and White male students. In the next section, we describe the methodology used for this study.

4. Method

4.1. Data Source

All data in this study are drawn from the High School Longitudinal Study of 2009—the most recent study conducted within the Secondary Longitudinal Studies Program by the National Center of Education Statistics (NCES) of the Institute of Education Sciences—under a restricted-use license. The High School Longitudinal Study of 2009 (HSLS:09) collected data from a nationally representative sample of ninth grade students entering a nationally representative sample of high schools in fall 2009 and follows the postsecondary trajectories of the students into adulthood (Duprey et al., 2018; Ingels et al., 2011). For the current study, we utilize school and student data constructed from surveys administered to students, parents, teachers, counselors, and principals. The data collection occurred in four waves: (a) base-year during the

2009-10 academic year; (b) first follow-up during the 11th grade year in spring 2012; (c) 2013 update administered immediately after the completion of high school credentials; (d) second follow-up in February 2016, which was approximately three years after high school completion (Duprey et al., 2018).

4.2. Sample

In the base-year within the HSLS:09, two-stage stratified random sampling was used to obtain a sample for the study. The first stage of stratified random sampling resulted in the identification of 1,890 eligible schools, and a total of 940 schools participated in the study. The second stage of stratified random sampling resulted in 25,210 study-eligible students from the 940 schools (an average of 25 students per school). A total of approximately 23,320 students[1] responded to the second follow-up questionnaire in February 2016 (Duprey et al., 2018).

Our analytic samples drawn from these schools and students are determined by several rules. First, because the school structures and academic pathways to STEM entry for students in public high school systems can be different from those in private schools, we thought an investigation using samples in private schools needs a separate study from public school. Accordingly, we limit our analytic samples to public high schools, which accounted for 770 of the 940 schools (81.9%) in the HSLS:09 sample. Second, among public schools, we further exclude 10 alternative schools which are defined as schools that offer a curriculum designed to provide nontraditional education to students (e.g., students vulnerable to school failure or dropout in a traditional setting). Last, we narrow our sample to African American, Latino/a/x, and White students, in the 2013 update data collection, who asserted that they enrolled in a

[1] All unweighted sample size numbers for students and schools are rounded to the nearest ten for compliance with National Center for Education Statistic policies for restricted-use data.

bachelor's or associate's degree program during the summer or fall semester immediately after high school completion.

We exclude other high school graduates and college enrollees for a few reasons. First, all high school graduates are not included in the analytic sample because college enrollees likely are unique in characteristics (e.g., academic achievement, career aspirations) from high school graduates who do not enroll in college. Second, high school graduates who enroll in college are the only graduates who can express the postsecondary STEM entry outcomes of interest to this study—STEM major choice goal in the first semester of college and STEM major choice action Third, we exclude Asian American students because, overall, they are a group of students of color identified as overrepresented in STEM fields, and the dataset does not permit analysis of different ethnicities of Asian Americans who might be underrepresented in STEM fields. Fourth, the sample size for students of color of other ethnicities were too small for analyses (i.e. Native Americans) in this study. As a result of these rules, the final analytic sample is 6,005 students nested within 750 public schools.

4.3. Measures

In this section, we describe how we constructed the measures shown in the conceptual model from the variables in the HSLS:09 dataset (National Center for Education Statistics [NCES], 2018). In terms of the student-related variables, we obtain measures of choice action, choice goal, self-efficacy, interest, demographics, and academic preparation. The only school-level variable in our study is a measure of STEM supports. To facilitate the replication of this study, a list of the variables used may be requested from the author. For each of these measures, we present descriptive statistics (e.g., unweighted mean and SD), in Table 1 and Table 2, computed based on our final analytic sample.

4.3.1. STEM Major Choice Action (Choice of a STEM Major)

STEM major choice action is a variable in the second follow-up three years after high school completion in spring/summer 2013 that measured choice of a STEM major. The variable indicates the college degree major a student was pursuing in February 2016 or when last enrolled in his or her associate's or bachelor's degree program. If a student selected double majors, which is roughly 4% of the college enrolled students in the HSLS:09 sample, the college major that counted as choice action, in this study, was the first degree program reported. This measure of choice action was selected because it was the most current measure of a student's college major choice at the time of our data analysis. Additionally, we believe there is little concern for using this measure in a study of STEM entry because we also measure student's choice goal in the first semester of college.

Within the analytic sample, three groups of students can be identified by using a STEM major choice action variable: undergraduate degree/certificate first major field of study is in STEM, undergraduate degree/certificate first major field of study is not in STEM, and don't know. The last two groups are combined together so that a new binary choice variable was created for analysis, where 1 meant a student had declared a STEM major, and 0 meant a student did not declare a STEM major (reference group). We observe that only 22.0% of the student analytic sample indicated their degree program of study was in a STEM major. A STEM major is first defined by the National Center for Education Statistics (NCES) designation of two-digit Classification of Instruction Program (CIP) codes embedded within the questionnaire then categorized as STEM according to the definition of STEM majors by the U.S. Department of Defense Science, Mathematics, and Research for Transformation (SMART) grant (NCES, n.d., 2018).

4.3.2. STEM Major Choice Goal (Intent to Declare a STEM Major)

We adopt a variable indicating a student's STEM major choice goal or intent to declare a STEM major in the first semester of college from the 2013 update data. All HSLS:09 students who graduated from high school and enrolled in courses at four-year and two-year postsecondary institutions in the United States by November 1, 2013 were eligible to answer this question. Three groups of students are identified based on this variable: intent to declare a STEM major, intent to declare a non-STEM major, and don’t know. We combine the last two groups together to create a new binary choice goal variable, where 1 meant a student had an intent to declare a STEM major, and 0 meant a student did not have an intent to declare a STEM major (reference group) according to NCES CIP codes. Among our analytic sample, we observe that 23.8% of the sample intended to declare a STEM major in the first semester of college.

4.3.3. Environmental Supports (High School STEM Supports)

We capture the extent to which a student was exposed to an environment with plentiful environmental supports through two items collected by the first follow-up (11th grade) survey of the HSLS:09. In other words, we quantify the number of high school STEM supports from two items. The first item asked school administrators what the school did in order to raise high school students' interest and achievement in math or science. Eight interventions (e.g., taking students on math- or science-relevant field trips; bringing in guest speakers to talk about math or science) were presented in the questionnaire. We constructed the environmental support item for these STEM interventions to have a range from 0 to 8. The second item asked school counselors what formal programs or systematic efforts were made to increase participation in STEM. Two STEM-relevant interventions were used to construct this measure from the counselor response: (a) encouraging underrepresented students to pursue STEM and (b) informing parents or guardians about STEM higher education or career opportunities. Thus, the score of the second item was constructed to range from 0 to 2. Then, we combined responses from school administrators and counselors to construct a single measure of environmental or high school STEM supports. As a result, our measure of high school STEM supports has a range from 0 (6 of 760 schools) to 10 (56 of 760 schools). This measure has a mean of 6.30 and a SD of 2.28. A higher score for this measure means a school is more likely to expose a student to a STEM-rich environment that encourages STEM career development.

4.3.4. STEM Self-efficacy during High School

We use the scale of a student's 11th grade math self-efficacy as a proxy for STEM self-efficacy because of its association with STEM entry (Hinojosa et al., 2016) and because math is an anchor subject in STEM success (Tyson & Roska, 2016). In the current study, the scale of math self-efficacy is constructed based on four-point Likert scale items (1 = strongly agree; 4 = strongly disagree) designed and reviewed by the HSLS:09 Technical Review Panel members. More specifically, we utilize the following four items administered to students in 2012 first follow-up: (a) *teen confident can do an excellent job on (spring 2012) math tests*; (b) *teen certain can understand (spring 2012) math textbook*; (c) *teen certain can master skills taught in (spring 2012) math course*; and (d) *teen confident can do excellent job on (spring 2012) math assignments* (Ingels et al., 2013). The score reliability (Cronbach's alpha) of these four items is .89 (Ingels et al., 2013). The measure of self-efficacy had a range from -2.50 to 1.73. This measure had a mean of 0.14 and a SD of 0.98. A higher value of self-efficacy indicates a student held more positive personal beliefs about his/her ability to perform well in math (Lent & Brown, 2013).

4.3.5. STEM Interest during High School

STEM interest in math, during the 11th grade, is used to indicate STEM interest as depicted in our conceptual model. Specifically, the scale of interest in math is constructed based on three four-point Likert scale items (1 = strongly agree; 4 = strongly disagree) and two multiple choice questions administered to students in the 2012 first follow-up (Ingels et al., 2013). The three Likert scale items were (a) *teen thinks (spring 2012) math course is a waste of time*; (b) *teen thinks (spring 2012) math course is boring*; and (c) *teen is enjoying (spring 2012) math course*. Two multiple choice questions were (a) *teen is taking spring 2012 math because he/she really enjoys math (yes/no)* and (b) *what [is/was] teen's favorite school subject (math is one of options)*. The weighted score reliability of these five items is .69 and was standardized to have a mean of zero and weighted standard deviation of one (Ingels et al., 2013). While this score reliability is not ideal, it is on the cusp of the satisfactory value of 0.7 (Bland & Altman, 1997; Cho & Kim, 2015) and higher than the HSLS:09 0.65 alpha criterion (Ingels et al., 2013).

The HSLS:09 measure of STEM interest had a range from -2.02 to 1.99. In our analytic sample, this measure had a mean of 0.09 and a SD of 1.00. A higher value of interest indicated a student had higher academic interest in math (Ingels et al., 2013; Lent & Brown, 2013).

4.3.6. STEM Career Choice Goal during High School

STEM career choice goal during high school is measured by one item that asked a student, during the 11th grade, the occupation he or she expected to have by age 30. This question was asked in the 2012 first follow-up. The STEM career choice goal during high school variable indicated whether a student expected his or her career to be STEM-related or not. Note for this study, health, social sciences, and psychology occupations are not considered STEM-related occupations. As a result, we observe that only 11.56% of the student analytic sample, during their 11th grade, expressed that they expected to have STEM-related occupations by age 30.

4.3.7. Covariates

Guided by the SCCT choice model (Lent et al., 1994), we control for the impacts of distal antecedents to a choice of a STEM major in our analyses. More specifically, an index of student socioeconomic status (SES) created in the HSLS:09 was included as a main covariate. The SES variable in the HSLS:09 is a composite variable that accounts for a student's SES background as represented by parents' education, parents' occupations, and family income measured in the base-year (Ingels et al., 2011). To the extent that gender and racial/ethnic differences in STEM entry are reduced as the SES of a student's family increases (Niu, 2017), the SES variable proxies students' environmental supports or contextual affordances at home, which can serve as additional educational and career-relevant resources (Lent et al., 1994; Flores et al., 2017). The index of SES is continuous in form and ranges from -1.82 to 2.57 with a mean of 0.22 and a SD of 0.75 in the analytic sample. School SES is not included in the analysis because some preliminary analysis indicates it is highly correlated with student SES. Other distal antecedents such as gender and ethnicity are our main grouping variables for the analyses.

Another covariate included in the study is a student's math achievement or standardized math score in their 9th grade year from the base-year student data. The score is a standardized *t*-score that can be used as a norm-referenced estimate of math achievement relative to the population (fall 2009 ninth graders) as a whole (Ingels et al., 2011). We adopt this variable to indicate a student's academic preparation in the first year of high school, which can set the trajectory of a student's development of social cognitive career attributes in favor of a STEM career. This covariate had a mean of 54.21 and a SD of 9.27 in the analytic sample. To facilitate the parameter estimation in the statistical models, we convert the student math achievement scores to Z scores (mean = 0 and SD = 1) for the analyses. Note the scale of this covariate is quite different from other analytical variables in the study.

The final covariate we consider is a student's highest level mathematics course taken with nominal categories from 0 (no math course) to 13 (AP/IB calculus) drawn from the 2013 Update data. We adopt this variable to indicate student academic preparation by the end of high school. For the analysis, thirteen categories for highest level math course taken are reduced to two categories representing three levels of mathematics courses taken: advanced (trigonometry, probability and statistics, precalculus, calculus, AP/IB calculus, other AP/IB math, and other advanced math; 76.08%) vs. non-advanced (23.92%, reference group).

4.4. Analytic Approach

To answer our research questions, multiple-group analysis is conducted in the framework of structural equation modeling (SEM). Multiple-group analysis (MGA) has been widely used in educational research to test the validity of theoretical models across different populations (Kline, 2011; Thompson & Green, 2006). Using MGA, the parameters of a statistical model can be estimated for each of the different groups separately within one analysis. More importantly, MGA allows researchers to test whether parameters in the statistical model can be assumed equal across groups. We apply this feature to assess whether there were gender and racial/ethnic differences in the impact of STEM supports and other SCCT choice constructs on the STEM choice action. The statistical package Mplus 8.2 (Muthén & Muthén, 1998-2017) was utilized for the data analysis.

A statistical model developed based on the conceptual model as shown in Figure 1 is specified for the MGA. Parameters of the statistical model are estimated for six groups (White females, White males, African American females, African American males, Latina females, and Latino males) simultaneously given the data of the analytic sample. Standardized coefficients of parameter estimates are reported in Figures 2 and 3 for each of the six groups for a comparison purpose.

Then, we test whether parameters in the statistical model can be assumed equal across groups through a series of Model Constraint syntax statements in Mplus. The Model Constraint command is used to (a) define a new parameter that represents the difference of a specific parameter estimate (e.g., the path from STEM supports to STEM major choice action) across different groups (e.g., White female vs. White male) and (b) then to test whether the new parameter is statistically equal to zero using the Wald chi-square test. If the new parameter is statistically equal to zero, the result suggests the group difference in the parameter estimate does not exist. Additionally, we apply the Model Indirect command to request indirect effects (e.g., STEM support → self-efficacy → STEM major choice action) and their standard errors (SEs). We also use the Bootstrap option to request the bootstrap SEs of the direct, indirect, and total effects. Moreover, when the missing data are presented, full information maximum likelihood (FIML) estimation in Mplus is used as a means of handling the missing data.

To derive accurate parameter estimates and standard errors for the analytic sample, both replicate weights and an analytical weight are incorporated in our analyses. More specifically, per the HSLS:09 study administrators' guidance, we use analytical weights for the base-year, first follow-up, 2013 update, and second follow-up and apply balanced repeated replication (BRR) weights to adjust the standard errors (Duprey et al., 2018). However, it is important to note that because the data used from this sample's responses lost national representativeness after the first wave of data collection, our findings will only be generalizable to our analytic sample.

5. Results

5.1. Descriptive Statistics

Generally speaking, the 6,005 ninth grade students from 750 regular public high schools matriculated to postsecondary institutions by fall 2016 were diverse (53.79% female, 11.02% African American, 15.85% Latino/a/x, 73.12% White), and nearly 24% of them initially expressed a STEM major choice goal in the first semester of college. Three years postsecondary, approximately 22% of the students took a STEM major choice action. Within each racial/ethnic subgroup, the proportion of students who made a STEM major choice action was not substantively different from the proportion of students who expressed a STEM major choice goal at the beginning of college. However, among the racial/ethnic subgroups, the proportion of African American students who expressed a STEM major choice goal and the proportion of African American students who took STEM major choice action was lower than their White and Latino/a/x peers. This difference in STEM entry is interesting because, on average, students in the overall analytic sample attended a high school with about six STEM supports, and on average, students within each subgroup attended a school with an average of about six STEM supports.

A point of difference within the sample is the academic preparation and socioeconomic backgrounds of the subgroups. We find African American and Latino/a/x students, on average, had less academic preparation and a lower SES than their White peers. In other words, in the first year of high school, the standardized math scores of Whites students were higher than the math scores of students of color, and a higher percentage of White students completed a math course of trigonometry or higher by the end of high school.

Table 1 shows that when we examine the data by gender, these racial trends with SES and STEM supports remain, but we find course-taking is different within and across gender while ninth grade math achievement is similar. A higher percentage of female students complete advanced math courses in high school than their male peers of the same race. These findings about similarities in access to STEM supports and differences in academic preparation suggest differences in STEM self-efficacy, STEM career choice goals, and STEM interest should exist because academic preparation influences self-efficacy which influences goals and interest.

Indeed, the descriptive data in Table 1 suggests differences in the social cognitive career attributes between female and male students. Female students are substantively distinct from male students as only about 6% of female students in each racial/ethnic group, respectively, expected to be in a STEM career by age 30 compared to approximately 22% of White males, 13% of African American males, and 13% of Latino males. This low occurrence of a STEM career choice goal during high school turns our attention to self-efficacy, one hypothesized source of choice goals (Lent et al., 2018).

We find that female students, on average, tend to have lower STEM self-efficacy than their male counterparts. African American female students, on average, expressed higher STEM self-efficacy during high school than any other female group. In fact, African American female students are the only female group whose average STEM self-efficacy during high school is positive.

Some other social cognitive career distinctions also emerged. White female students, on average, possess more STEM interest during high school than their White male counterparts and more STEM interest during high school than their female peers of other races/ethnicities. Latina female students, on average, are the only female group with lower STEM interest than their male counterparts of the same ethnicity. In the next section, we show the extent to which the SCCT choice model explained the variance in each construct by race/ethnicity and gender. For the sake of brevity, we will leave STEM and designations of time (i.e., during high school, during the first semester of college, three years postsecondary) off the name of the constructs when not necessary for interpretation.

5.2. Model Fit to Analytic Sample Data

Using the Model Indirect command in Mplus, we were able to request the estimates of ten indirect effects of STEM supports on major choice action and their bootstrap SEs for each gender and racial/ethnic group. Table 2, Figure 2, and Figure 3 show standardized parameter estimates of the direct, indirect, and total effects of STEM supports on choice of a STEM major. The total effect is the sum of all indirect effects and the direct effect. These effects are reviewed after we briefly discuss the model fit to the HSLS:09 data, in other words, how well the SCCT choice model explains the STEM choice action and STEM choice goal in our analytic sample.

We analyze model fit for all students and each gender within the three racial/ethnic categories. Namely, R^2 values are in the order of male and female students for each racial/ethnic group. The R^2 for continuous variables (11th grade self-efficacy and interest) can be interpreted as a regular R^2 in regression, while R^2 for categorical variables (outcome expectation for STEM career by age 30, STEM major choice goal in the first semester of college, and choice of a STEM major three years postsecondary) can be understood as an explained variance proportion in an underlying continuous latent response variable (see Muthén, 1998-2004), which is also similar to the regular R^2.

Within our sample of only high school graduates, who enrolled in an associate's degree or bachelor's degree program, the model differentially explains variance in SCCT choice constructs. For White male and female students, the SCCT choice model and covariates jointly account for .09/.06, .17/.06, .34/.38, .52/.44, and .71/.68 of the variance in self-efficacy during high school, career choice goal, interest, major choice goal, and major choice action, respectively. For African American male and female students, the SCCT choice model and covariates jointly account for .16/.10, .17/.10, .46/.38, .63/.55, and .76/.44 of the variance in self-efficacy, career choice goal, interest, major choice goal, and major choice action, respectively. Among the Latino/a/x student sample, the SCCT choice model and covariates jointly account for .07/.05, .30/.29, .54/.44, .62/.47, and .82/.81 of the variance in self-efficacy, career choice goal, interest, major choice goal, and major choice action, respectively, for males and females.

Taken together, we find the amount of variance the SCCT choice model explains of STEM major choice action three years postsecondary and STEM major choice goal in the first semester of college was more than the variance the model explained for the other social cognitive career attributes. Additionally, among the six demographic groups, the model explained more variance in the constructs for male samples than their female samples of the same race. The group with the least amount of variance in their major choice action explained was African American female students followed by White female students. Interestingly, African American female students also are the only group among all six subgroups whose variance in major choice action is less than the variance explained in their STEM major choice goal. Another intriguing finding is the model explains the most variance in Latino/a/x students' major choice action, and the amount of variance in major choice action explained for Latina females and

Latino males is nearly similar. In the sections that follow, we compare the path relationships between the different groups, and Figures 2 and 3 depict the within-gender comparisons.

5.2.1. STEM Major Choice Goal

Consistent with the SCCT choice model, we find the STEM major choice goal to be the strongest predictor of a STEM major choice action irrespective of race/ethnicity or gender. White male and female students' major choice goal positively affects their major choice actions (0.75/0.81). African American male and female students' major choice goal strongly and positively affects their major choice action (1.05/0.79). Latino/a/x students' major choice goal also positively impacts their choice action (0.65/0.71). What is more intriguing in our results is the relationship between the major choice goal, major choice action, interest, and the other SCCT choice constructs.

5.2.2. STEM Interest during High School

According to the SCCT choice model, interest should be the strongest, positive direct predictor of STEM major choice goals, and self-efficacy should be a positive direct predictor of interest. In the current study, we use math interest in the 11th grade as the measure of interest. We find a statistically significant relationship between interest and the major choice goal, and self-efficacy and the career choice goal are drivers of interest. However, the direction of the relationship interest has with these other attributes varies by race/ethnicity and gender. Namely, among White students, we find only a positive impact of interest (0.10) on major choice goal for White female students, and interest (0.00) has no statistically significant impact on the major choice goal of White male students. Interest also has statistically different effects on African American female, African American male, and Latino male students' major choice goal. While interest exerts a negative impact (-0.27) on the major choice goal for African American female students, interest has a positive impact on the STEM major choice goal (0.23) for African American male students. For Latino/a/x students, interest has a negative impact on the major choice goal of male students (-0.21) and no statistically significant impact on the major choice goal of female students (0.11). Put another way, we find no consistent effect of STEM interest during the 11th grade on a STEM major choice goal in the first-semester of college. Next, we discuss STEM self-efficacy and the STEM career choice goal.

5.2.3. STEM Self-efficacy during High School

The SCCT choice model posits that STEM self-efficacy is driven by accomplishments or failure in past learning experiences, and, in relation to other SCCT choice constructs, STEM self-efficacy should positively influence STEM interest and the STEM career choice goal during high school (Lent, 2013; Lent et al., 2018). In our analysis, we find the self-efficacy of White male and female students exhibits positive impacts on their interest (0.45/0.58) and career choice goal (0.23/0.13). Additionally, self-efficacy has a small impact on White students' major choice goal (0.09/0.06). Regarding the direct influence of self-efficacy on their major choice action, we only observe a statistically significant relationship between self-efficacy and the major choice action for White male students (0.05).

For African American male and female students, self-efficacy has nearly similar positive impacts on their interest (0.54/0.53) but has no impact on their career choice goal. Self-efficacy also exhibits no influence on African American students' major choice action. On the other hand, we find a negative impact of self-efficacy on African American males' major choice goal (-0.23) and a positive influence on the major choice goal of African American female students (0.21).

For Latino/a/x students, self-efficacy yields positive effects on both their career choice goal (0.28/0.22) and interest (0.36/0.67) with the impact on female students being greater. With less alignment to the SCCT choice model, we find self-efficacy does not significantly influence Latino male and Latina female students' major choice goal. On the other hand, self-efficacy positively and significantly influences the major choice action (0.29) among Latino male students but not Latina female students (-0.04). Taken together, we find STEM self-efficacy during high school to be important in the production of STEM interest during high school for all genders and racial/ethnic groups, but STEM self-efficacy during high school does not increase the likelihood of a STEM career choice goal during high school for all groups.

5.2.4. STEM Career Choice Goal during High School

In our study, we find STEM career choice goal during high school has a stronger relationship with STEM major choice goal in the first semester of college than STEM interest during high school for every subgroup of students, and there is no statistically significant difference in this relationship between White students and students of color. However, the STEM career choice goal displays a variety of relationships with STEM interest and STEM major choice action depending on the group.

A career choice goal has no statistically significant direct impact on White male students' major choice action but a statistically significant, negative impact on major choice action for White female students (-0.13). The career choice goal, however, does exert a strong, positive influence on White male and female students' major choice goal (0.64/0.52) in the first semester of college with the impacts on male students being statistically stronger than female students. A career choice goal also positively contributes to interest for White male students and White female students (0.20/0.07).

Among racial/ethnic groups historically underrepresented in STEM fields, a career choice goal is a strong predictor of their major choice goal but varies in impact on their interest and major choice action. Among African American students, a career choice goal differentially influences male and female students' interest (-0.31/0.26). Yet, a career choice goal similarly influences African American students' major choice goal (0.79/0.72) and their major choice action (-0.31/-0.35). Regarding Latino/a/x students, a career choice goal differentially influences male (0.49) and female interest (-0.23). Additionally, the impact of career choice goal on major choice goal (0.83/0.65) was similar for Latino male students and Latina female students. Further, a career choice goal does not influence Latino male students' choice action but does influence Latina female students' choice action (0.24). In sum, these findings, for our sample in the high school-to-college continuum, show that a STEM career choice goal during high school has a stronger relationship to the STEM major choice goal in the first semester of college than STEM interest or STEM self-efficacy during high school.

5.2.5. High School STEM Supports

Table 2 displays a closer look at the relationship between the quantity of STEM supports available in a student's high school and the student's STEM major choice action three years postsecondary. We find no one path from STEM supports to the major choice action was common among the various groups, but African American female students and White male students stand out for the lack of a direct effect of STEM supports on their major choice action. On the other hand, African American female students have at least one indirect path from STEM supports to major choice action from STEM supports via self-efficacy, interest, and the major choice goal (SUP→SE→INT→COL-GO→CHO). No indirect effects are observed for White male students.

Among the other groups historically underrepresented in STEM, the direct and indirect effects vary. For White female students, the quantity of high school STEM supports available exhibits negative direct and total effects on their major choice action. However, White female students also have two indirect ways STEM supports can influence their major choice action. Namely, White female students are the only group with a statistically significant positive indirect path from STEM supports to major choice action mediated only by a career choice goal during high school (SUP→HS-GO→CHO). Secondly, a negative indirect path via a path from a career choice goal to major choice goal (SUP→ HS-GO→COL-GO→CHO) is statistically significant for White female students. This indirect path (SUP→ HS-GO→ COL-GO→CHO) also is negative and statistically significant among Latino male students and Latina female students.

The other significant paths for Latino/a/x students varied by gender. For Latina female students, the quantity of high school STEM supports available had a positive direct effect on their major choice action, and this effect was the largest direct effect observed among all six groups in the analytic sample. On the other hand, Latino male students were the only subgroup with positive indirect paths mediated by a major choice goal alone (SUP→COL-GO→CHO) and by a path through a career choice goal to interest then to major choice goal (SUP→HS-GO→INT→COL-GO→CHO). However, the latter path was not practically large enough. The Latino male sample also showed positive direct and total effects from the quantity of high school STEM supports available to major choice action. For African American male students, only direct and total effects were statistically significant, and these effects are positive. Taken together, the quantity of high school STEM supports available has some type of effect on major choice action three years postsecondary for every group except White males. In light of this finding, we consider Figures 2 and 3 to see if supports may be significant to the development of other social cognitive career attributes.

We find that among White students, the STEM supports had no statistically significant impact on White male students' self-efficacy, career choice goal, or major choice goal. For White female students, we find a negative and statistically significant effect of supports on their career choice goal (-0.09), but the quantity of high school STEM supports available enacted no statistically significant effect on White female students' self-efficacy and major choice goal.

On the other hand, self-efficacy is the only attribute the quantity of high school STEM supports available significantly impacts for African American female students (0.25). For African American male students, the career choice goal is the only attribute the quantity of high school STEM supports available statistically significantly impacts. For Latino/a/x students, the quantity of high school supports available negatively and significantly influences both male and female students' career choice goal (-0.19/-0.20). As a point of gender difference for Latino/a/x students, the quantity of high school STEM supports available only has a positive effect on male students' major choice goal (0.23) not female students. In all, these results about the influence of a high school environment with more STEM supports on a student's STEM major choice action three years postsecondary and on other social cognitive career attributes varies by race/ethnicity and gender. In the next section, we discuss these implication and recommendations for future research from these findings.

6. Discussion

To increase the likelihood that groups historically underrepresented in STEM will persist in a STEM major, these students need to be academically prepared to take a STEM course of study and should select their STEM major within the first year of college (Riegle-Crumb et al, 2019). As such, social cognitive career attributes and high school STEM supports that contribute to the STEM entry of students within the high school-to-college continuum are paramount to equitable access to fast-growing, high-paying STEM careers for all citizens and residents of the United States. The current study utilized the SCCT choice model to highlight what social cognitive career attributes are important to groups historically underrepresented in STEM fields and to determine the impact of attending a school with more STEM supports on postsecondary STEM major choice action.

6.1. Model Tenability for Explaining STEM Entry by Race/Ethnicity and Gender in the High School-to-College Continuum

We found the SCCT choice model was tenable in modeling predictors of high school graduates' postsecondary STEM major choice goal in the first semester of college and STEM major choice action three years postsecondary within and across gender and race/ethnicity. The model explained at least 44% of the variance in choice of a STEM major for African American female students and 68% to 72% of the variance in STEM major choice of across the other five groups. The contributions to variance for each subgroup in this study are higher than the 43% of variance in the STEM choice action explained by the SCCT choice model in the recent meta-analysis of samples comprised of samples ranging from high school to graduate school (Lent et al., 2018). Ultimately, this finding suggests that the SCCT choice model is ideal for describing STEM career development in the high school-to-college continuum, where a substantial amount of career decision making occurs. We recommend that future research on STEM underrepresentation include the SCCT choice model constructs as covariates in any model of STEM entry. With only less than one-third of variance in the STEM major choice action three years postsecondary left unexplained for five racial/ethnic and gender groups in our study modeling SCCT constructs with HSLS:09 data, we posit that scholars may better identify which pre-college factors are promoting or discouraging STEM entry if they include SCCT constructs in their models.

6.2. Making STEM Entry Equitable with High School STEM Supports

We also recommend scholars and practitioners consider the role different high school STEM supports can play in students' career development and postsecondary STEM entry. For example, we found the STEM entry pathway of African American female students is unique as they were the only female group in our sample to exhibit positive self-efficacy and the only female group whose self-efficacy was statistically significantly influenced by the number of STEM supports available in a high school. However, their positive self-efficacy did not contribute significantly to their STEM career choice goal, STEM major choice goal, nor STEM major choice action. Whereas each subgroup of students attended a school with an average of about six STEM supports, attending a school with at least six STEM supports was not enough to increase the likelihood of African American females developing STEM career choice goals, STEM major choices or taking STEM major actions. Beyond providing STEM supports, schools must ensure the students are accessing the STEM supports. To the extent that STEM supports can be unequal in quality between schools and inequitable in effectiveness, we suggest future researchers employ the modeling of the SCCT choice model with a single STEM support as a predictor to determine whether specific STEM supports yield better and more equitable social cognitive career outcomes for all students according to race/ethnicity and gender.

7. Conclusions

In sum, there are two major findings in this study. First, the SCCT choice model is a suitable model for explaining postsecondary STEM entry in the high school-to-college continuum, but the significance of specific social cognitive career attributes depends on both the race/ethnicity and gender of the student. Second, high school STEM supports play an important role in increasing the STEM entry of some students.

Because the choice goal of expecting a STEM career at age 30 was found to be significantly correlated with the STEM major choice goal in the first semester for college, we would recommend high schools use STEM supports that expose high school students to young STEM role models as research shows role models to be a positive support in STEM career development (Griffith, 2010; Fouad et al., 2010; Fouad & Kantamneni, 2013; Quimby & De Santis, 2006). Perhaps young STEM role models (e.g., in their 20s or early 30s) can contribute not only to students' positive imagination of career outcomes but also to their positive perception of the span of time between getting a STEM degree and achieving career success. Additionally, female STEM role models can help female students overcome traditional gender socialization and stereotypes about male-dominated STEM careers.

The findings of this study may be especially useful to school leaders seeking to implement school reforms to enhance STEM entry across diverse student groups. School leaders may also seek partnerships with universities through which causal research studies could be conducted. Such studies would better elucidate the factors most effective in promoting STEM entry and persistence and represent an important addition to the correlational research reported in this study.

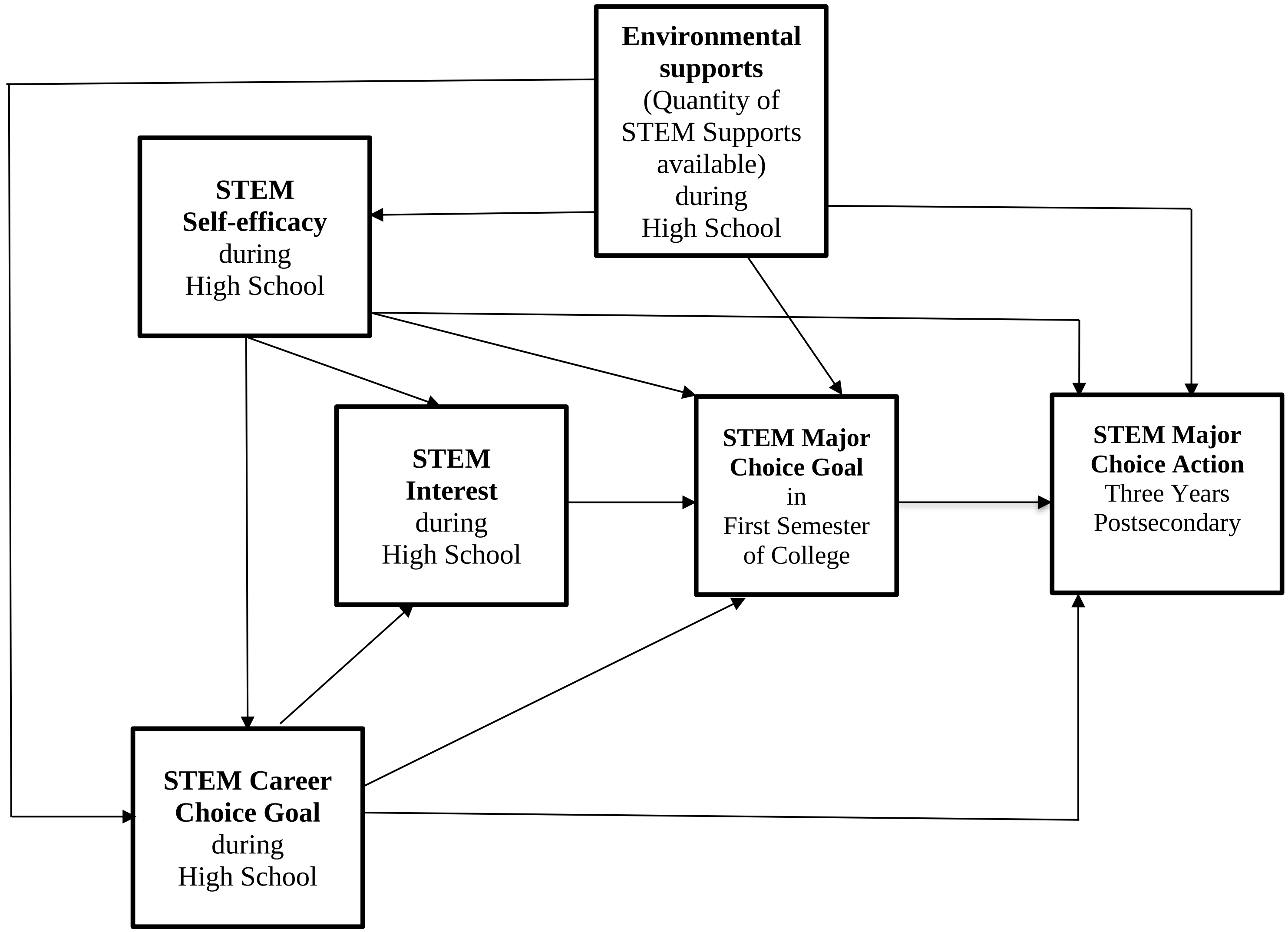

FIGURE 1. *Conceptual model of STEM major choice action adapted from Lent, Brown, & Hackett's (1994, 2000) SCCT choice model and Lent et al.'s (2018) SCCT choice model meta-analysis.*

Table 1

Unweighted Means and Standard Deviations for Demographic, Academic, and SCCT Choice Variables by Race/Ethnicity and Gender

	All				White				African American				Latino			
	Male		Female		Male		Female		Male		Female		Male		Female	
	%	*M*	%	*M*	%	*M*	%	*M*	%	*M*	%	*M*	%	*M*	%	*M*
Characteristic		*(SD)*		*(SD)*		*(SD)*		*(SD)*		*(SD)*		*(SD)*		*(SD)*		*(SD)*
Demographic																
Socioeconomic Status		0.26		0.19		0.40		0.33		0.04		-0.02		-0.25		-0.27
		(0.76)		(0.75)		(0.71)		(0.70)		(0.75)		(0.75)		(0.76)		(0.73)
SCCT Constructs																
High School																
Environmental		6.26		6.24		6.19		6.15		6.56		6.59		6.41		6.38
Supports (quantity)		(2.30)		(2.37)		(2.28)		(2.36)		(2.25)		(2.29)		(2.39)		(2.12)
Self-efficacy		0.31		-0.00		0.30		-0.02		0.32		0.18		0.34		-0.04
(in math)		(0.93)		(0.99)		(0.94)		(1.01)		(0.88)		(0.91)		(0.92)		(0.97)
Interest		0.14		0.05		0.11		0.20		0.10		0.15		0.29		0.11
(in math)		(1.00)		(1.00)		(0.99)		(1.00)		(1.00)		(1.01)		(1.02)		(0.99)
Choice Goal	20.00		6.23		22.39		6.14		13.36		6.94		13.07		6.11	
(STEM career at 30)																
Postsecondary																
Choice Goal	33.95		15.00		35.91		16.04		19.92		13.20		33.65		11.37	
(STEM major)																
Choice Action	30.32		15.05		31.83		15.08		18.84		15.94		30.13		14.25	
(STEM major)																
Academic Preparation																
Standardized Math		54.55		53.91		55.75		55.10		48.97		49.38		52.73		51.74
Score		(9.27)		(8.97)		(9.34)		(8.73)		(9.74)		(8.80)		(9.02)		(8.75)
(9th Grade)																
Highest level Math	74.31		77.58			77.68		80.14		60.58		71.27		67.67		70.32
(Advanced)																

Note: SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), “Base-Year through 2013 Update, Student File and School File.”

Table 2

Standardized Direct, Indirect, and Total Effects (bootstrap standard errors) of STEM supports on STEM Major Choice Action

Effect	All Students	White Male	White Female	African American Male	African American Female	Latino Male	Latina Female
Indirect Effect							
SUP→SE→CHO	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	-0.00 (0.01)	-0.00 (0.03)	-0.01 (0.02)	0.00 (0.01)
SUP→HS-GO→CHO	-0.02 (0.01)	-0.00 (0.00)	0.01* (0.01)	-0.03 (0.03)	0.01 (0.03)	-0.02 (0.02)	-0.05 (0.03)
SUP→COL-GO→CHO	0.01 (0.01)	0.02 (0.01)	0.00 (0.02)	0.00 (0.07)	-0.12 (0.08)	0.15* (0.04)	0.05 (0.04)
SUP→SE→HS-GO→CHO	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.01 (.0.01)	-0.00 (0.00)	-0.00 (0.00)
SUP→SE→COL-GO→CHO	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.02 (0.02)	0.04 (0.02)	-0.00 (0.01)	-0.00 (0.01)
SUP→HS-GO→COL-GO →CHO	-0.01 (0.01)	-0.01 (0.01)	-0.04* (0.01)	0.07 (0.07)	-0.01 (0.05)	-0.10* (0.04)	-0.09* (0.03)
SUP→SE→IN→COL-GO →CHO	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.01 (0.01)	-0.03* (0.01)	0.00 (0.00)	-0.00 (0.01)
SUP→HS-GO→IN→COL-GO →CHO	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.01 (0.01)	0.00 (0.00)	0.01* (0.01)	0.00 (0.00)
SUP→SE→HS-GO→COL-GO →CHO	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	-0.01 (0.01)	0.01 (0.02)	-0.01 (0.01)	-0.01 (0.01)
SUP→SE→HS-GO→IN→ COL-GO→CHO	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Direct Effect	0.02 (0.03)	-0.03 (0.02)	-0.07* (0.02)	0.12* (0.05)	0.12 (0.13)	0.11* (0.05)	0.20* (0.07)
Total Effect	0.00 (0.03)	-0.02 (0.02)	-0.08* (0.02)	0.16* (0.08)	0.01 (0.10)	0.12* (0.05)	0.10 (0.07)

Note. SUP = STEM supports. SE = STEM self-efficacy during high school. HS-GO = STEM career choice goal during high school. IN = STEM interest during high school. COL-GO = STEM major choice goal in first semester of college. CHO = STEM major choice action three years postsecondary. Bootstrap standard errors are presented in the parentheses. *$p < .05$.

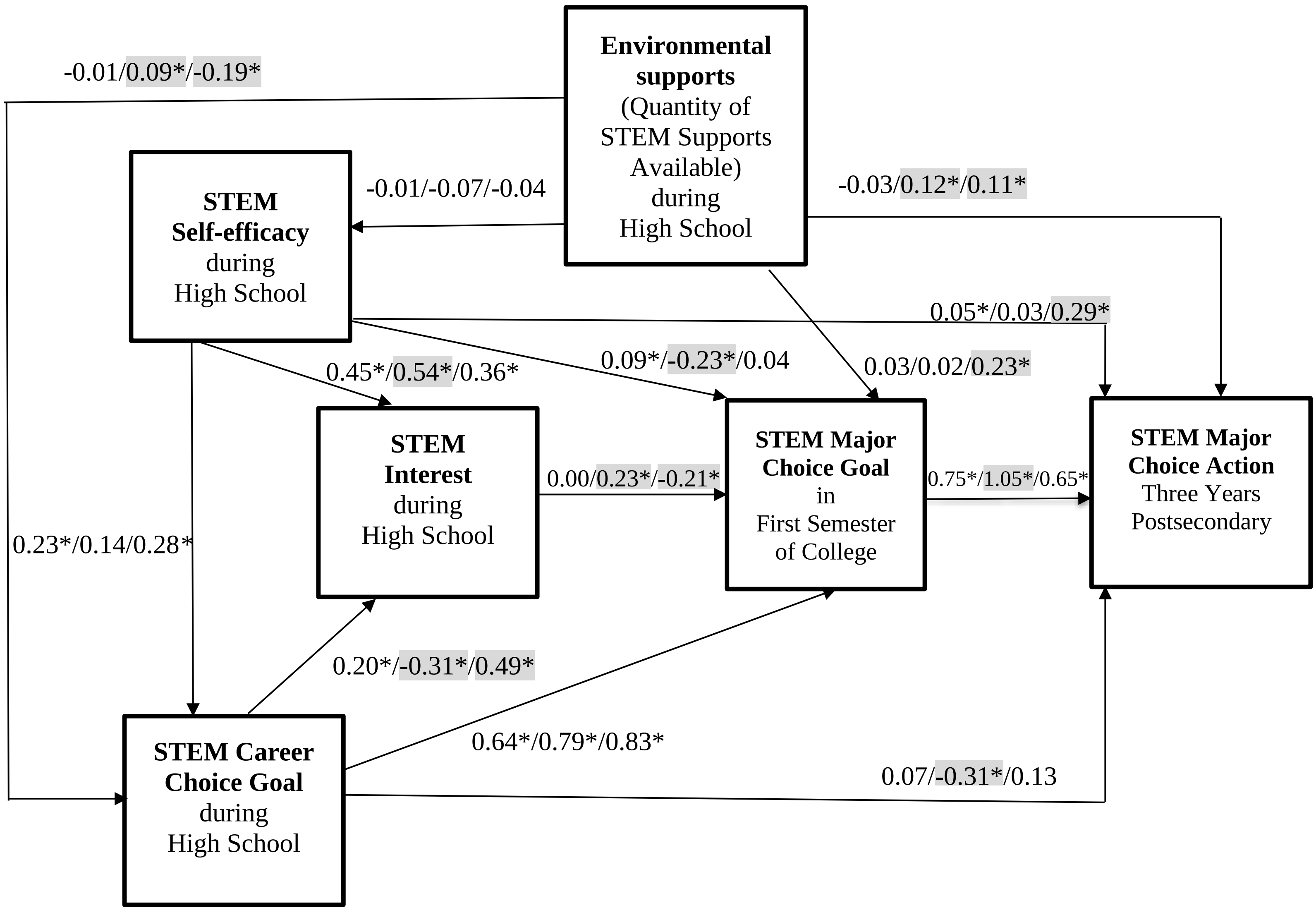

FIGURE 2. Standardized parameter estimates in the order of White, African American, and Latino male students. African American and Latino/a/x students were compared to White students, respectively (i.e., African American vs. White and Latino vs. White). Estimates in gray shading indicated there was a statistically significant group difference ($p < .05$). *$p < 0.05$

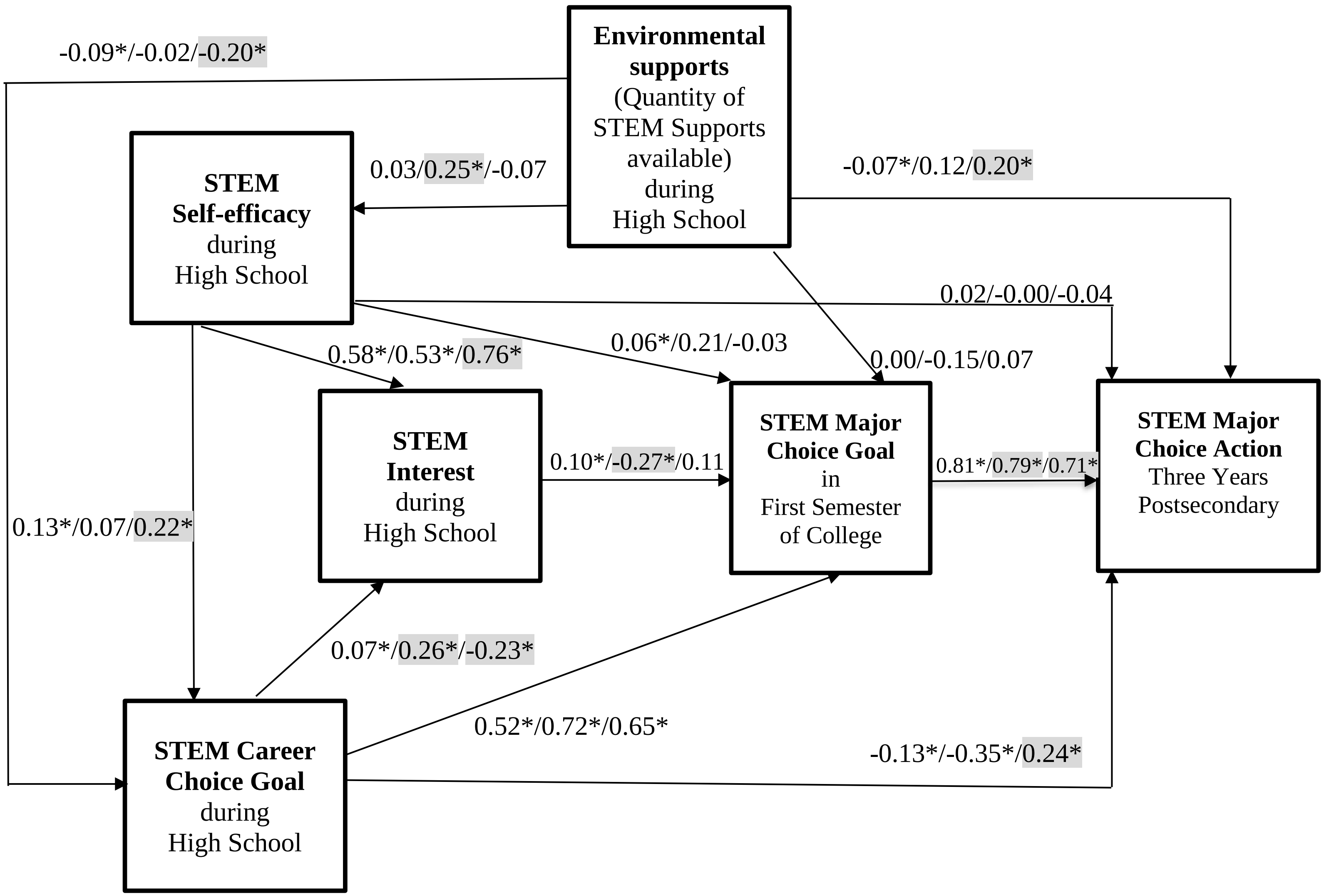

FIGURE 3. Standardized parameter estimates in the order of White, African American, and Latina female students. African American and Latino/a/x students were compared to White students, respectively (i.e., African American vs. White; and Latina vs. White). Estimates in gray shading indicated there was a statistically significant group difference ($p < .05$). *$p < 0.05$

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