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Influence of Social Cognitive and Ethnic Variables on Academic Goals of Underrepresented Students in Science and Engineering: A Multiple-Groups Analysis

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Abstract

This study investigated the academic interests and goals of 223 African American, Latino/a, Southeast Asian, and Native American undergraduate students in two groups: biological science and engineering (S/E) majors. Using social cognitive career theory (Lent, Brown, & Hackett, 1994), we examined the relationships of social cognitive variables (math/science academic self-efficacy, math/science outcome expectations), along with the influence of ethnic variables (ethnic identity, other-group orientation) and perceptions of campus climate to their math/science interests and goal commitment to earn an S/E degree. Path analysis revealed that the hypothesized model provided good overall fit to the data, revealing significant relationships from outcome expectations to interests and to goals. Paths from academic self-efficacy to S/E goals and from interests to S/E goals varied for students in engineering and biological science. For both groups, other-group orientation was positively related to self-efficacy and support was found for an efficacy-mediated relationship between perceived campus climate and goals. Theoretical and practical implications of the study's findings are considered as well as future research directions.

Keywords

social cognitive career; ethnic identity; science and engineering; career goals; underrepresented students

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Influence of Social Cognitive and Ethnic Variables on Academic Goals of Underrepresented Students in Science and Engineering: A Multiple-Groups Analysis

Science and engineering capability will be the foundation of economic success for the U.S. in the 21st century (Busch, 2005). Yet, the national demand for workers in science, technology, engineering, and mathematics (STEM) far exceeds the national supply of STEM-trained individuals (National Science Board (NSB), 2008). The Committee on Science, Engineering and Public Policy (2007), U.S. Innovation (2005), and others have called for new investments in higher and postsecondary education to create a significantly larger, more diverse talent pool of individuals interested in science, engineering, and technical careers. One important strategy for meeting the STEM talent development challenge is to address retention of domestic targeted minority students (i.e., *A*frican Americans, *L*atino/as, South East *A*sians, and *N*ative *A*mericans; collectively referred to hereafter as ALANA) in STEM.

Asian Americans in general have the highest U.S. college graduation rates with a large percentage in STEM fields (Reeves & Bennett, 2004). However, disaggregated data reveal that Southeast Asians, largely comprised of Cambodian, Vietnamese, Hmong and Laotian individuals (Niedzwiecki & Duong, 2004), have the highest high school dropout rates and the lowest college graduation rates of all U.S. ethnic groups based on the 2006 American Community Survey from the U.S. Census Bureau (Le, 2009, website). Further, Southeast Asians are least likely of all Asian Americans to be in managerial and professional occupations [where most STEM fields are grouped] (Reeves & Bennett). Based on these statistics, it is likely that Southeast Asians are underrepresented in science and engineering (Joan Burrelli, personal communication, June 4, 2009). Thus, our study included Southeast Asians as underrepresented ALANA students in STEM, one of few studies to consider their academic and career development.

National surveys of freshmen indicate that the intentions of ALANA students to major in a STEM field are similar to the intentions of White students (NSB, 2006). However, by the sixth year of college, only about 29% of ALANA students entering STEM majors graduate with a STEM degree compared to 42% of White students entering STEM majors (Hayes, 2007). Though scholarship exists on interventions to reduce attrition of ALANA students from STEM, it is largely comprised of program evaluations and minimal research that attends to the influence of cultural variables on retention. Further, few STEM retention efforts are informed by theory-driven research and are thus often reliant upon anecdotal or folk insights to guide their efforts (Lewis, 2003), delivering interventions that may not be effective or culturally relevant for ALANA students. Identifying influences on retention-related variables for ALANA students in STEM majors would help career counselors, higher education staff and faculty better focus their retention efforts on factors that have a significant impact on persistence. The purpose of this study was to examine influences on retention-related variables for ALANA students pursuing STEM degrees.

Influences on STEM Academic and Career Development

Several factors have emerged in the research literature as contributing to ALANA STEM retention, generally falling into three categories: contextual, cultural, and cognitive factors. The research on contextual factors indicates that ability is not necessarily a primary contributor to attrition: capable students leave the sciences. Seymour and Hewitt (1997) found that ALANA men and women, as well as White women, leave STEM fields in spite of their good academic standing, often citing uncomfortable classroom experiences. For instance, a study of classroom experiences in engineering revealed that ALANA students felt that faculty treated them differently than White students and perceived a ‘chilly climate’ from their White and male peers (Cabrera, Colbeck, & Terenzini, 2001). In a national survey of African American engineering undergraduates conducted by Brown, Morning, and Watkins (2005), students perceived significant campus racism and discrimination which were negatively associated with their graduation rates. These studies suggest that perceptions of both general campus climate and specific classroom climate, comprised of numerous interactions with faculty, staff, and peers, together inform overall opinions of the academic learning environment. ALANA students' perceived congruence or "fit" within their academic context has a subsequent impact on their attitudes and behavior (Schmitt, Oswald, Friede, Imus, & Merritt, 2008).

For instance, the accumulation of daily verbal, behavioral, or environmental "microaggressions" (Sue, Capodilupo, Torino, Bucceri, Holder, Nadal et al., 2007) commonly experienced by ALANA students (e.g., having contributions in a study group invalidated when a White peer's similar contributions are affirmed) directly affect their perceptions of campus climate and their academic performance, including dropping a class, changing majors, or even leaving the university (Solórzano, Ceja, & Yosso, 2000). Negative climate perceptions may compromise ALANA students' academic confidence, interests, and motivation to pursue their academic goals. Understanding and analyzing perceptions of campus climate is critical to examining college access, persistence, and graduation for ALANA students (Solórzano et al.).

Further, the majority of ALANA students enrolled in four-year colleges and universities matriculate at predominantly-White campuses (National Center for Education Statistics, 2005), wherein their "minority" status in STEM majors may be particularly salient. Thus, cultural factors such as having a positive ethnic identity may be important to maintain their confidence in their academic pursuits (Phinney, 1992) and perceptions of campus climate.

Ethnic identity refers to individuals' self-identification as an ethnic group member, sense of belonging to and positive regard for their own ethnic group (Phinney). One study found that participating in racially and ethnically affirming "counter-spaces" reinforced ALANA students' sense of ethnic identity and helped counteract negative campus climate experiences (Solórzano et al., 2000). Research has also shown that ethnic identity can promote academic confidence (cf. Oyserman, Harrison, & Bybee, 2001). That a subjective sense of one's academic competence can be bolstered by a positive ethnic identity may be a function of several dynamics. For instance, a grounded ethnic identity may keep ALANA individuals from subscribing to negative cultural stereotypes (e.g., others' perceptions that ALANAs lack intellectual competence to succeed in STEM; Seymour & Hewitt, 1997) which, once internalized, may weaken their academic confidence (Guzmán, Santiago-Rivera, & Haase, 2005; Phinney). Also, cultural pride in the legacy of achievements in one's ethnic group (associated with positive ethnic identity) can bolster one's motivation to learn and do well academically, thereby continuing the group's achievement legacy. Situating personal academic attainment within the context of cultural group advancement is consistent with what Oyserman et al. term "embedded achievement."

Similarly, positive attitudes toward and comfort interacting with individuals outside of one's ethnic group, defined as other-group orientation (Phinney, 1990; Smith, 1991), may also be adaptive for ALANAs in STEM. ALANA college students who are comfortable interacting with other ethnic groups may observe a diversity of successful peers in STEM, learn from their academic successes, and receive social support from them as well. These inter-ethnic experiences, in turn, may increase ALANA students' academic confidence and beliefs that pursuing STEM majors is a worthwhile effort. Moreover, ALANA students at predominantly-White campuses who are comfortable with inter-ethnic interactions, presuming that such comfort signals these interactions are generally positive, may also perceive favorable campus climates. The benefits of a bicultural or other-group orientation for ALANA individuals are supported in research including a perceived personal richness resulting from knowledge gained through exposure to different kinds of life experiences, fewer negative attitudes toward culturally different groups, and moderation of the negative effects of perceived discrimination (Bell, 1990; Lee, 2003; Soriano, Rivera, Williams, Daley, & Reznik, 2004). The constructs of ethnic identity and other-group orientation, which are conceptually related but separate constructs, are useful for understanding ALANA students' academic-related cognitions that inform their goal behavior. No studies were found that examined these constructs together with ALANA STEM students.

Finally, cognitive factors like academic self-perceptions influence achievement behaviors and performance (Schunk & Meese, 1992). Indeed, Bandura (1997) asserted that individuals' level of motivation and actions are based more on what they believe than on what is objectively the case. One of the more well-researched cognitive factors in academic and career development literature is self-efficacy. Self-efficacy (confidence in one's ability to successfully perform a given task) is highly correlated with choice of and persistence in a STEM major (Lent, Brown, & Larkin, 1986; Lent, Brown, Brenner et al., 2001). Research indicates that poor social climates can compromise and artificially deflate ALANA students' self-efficacy perceptions relative to their STEM academic pursuits (Seymour & Hewitt, 1997). Yet, a student with a robust sense of academic self-efficacy may be impervious to poor campus climates, such that efficacy beliefs mediate the influence of perceptions of the environment on academic outcomes. The central role that cognitive factors play in STEM retention for ALANA students may be better understood in relation to students' perceptions of their college environments, ethnic identity and other-group orientation.

Intervening in the academic and career behavior of ALANA students necessitates an understanding of mechanisms by which contextual, cognitive, and cultural variables exert their influence on academic and career-related processes and outcomes. Social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994) is a useful framework that articulates the effects of cognitive, contextual, and cultural factors on academic and career-related interests, goals, and choices for ALANA groups and has been empirically supported in numerous studies of STEM-related variables with diverse undergraduates (cf. Byars-Winston & Fouad, 2008; Lent et al., 1986; Lent, Brown, Sheu et al., 2005).

Theoretical Framework

Lent et al. (1994) proposed SCCT building upon the initial work of Bandura (1986) and Betz and Hackett (1983). SCCT depicts how learning and resultant academic and career-related behavior occur through interactions between individuals and their environment. A central tenet of the theory posits that academic and career-related interests, goals, and choices develop in part from relevant self-efficacy beliefs and outcome expectations (beliefs about the consequences of a particular course of action) (see Figure 1). Simply stated, whereas self-efficacy relates to the question, "Can I do this?" outcome expectations address the question, "If I do this, what will happen?" Personal self-efficacy beliefs and outcome expectations inform individuals' personal agency for self-regulation, self-directed learning, motivation, and goal setting in guiding personal behavior. The more confident college students are in their ability to perform well academically (i.e., academic self-efficacy) and believe that the outcomes associated with achieving a college degree are worthwhile the more likely they are to persist in pursuing their degree and set goals to realize their desired outcome, even in the face of challenges. Self-efficacy and outcome expectations greatly determine aspirations, motivation and commitment.

According to SCCT, self-efficacy beliefs and outcome expectations are important mediators between individuals' personal characteristics or person factors (e.g., race, ethnicity, gender), contextual background factors (e.g., family expectations), and learning experiences (e.g., academic preparation) and their eventual academic and career choice behaviors. Contextual factors that are more proximal to one's actual academic and career experience are also important such as perceptions of anticipated social supports (e.g., mentors) and barriers (e.g., racism, sexism) to realizing one's goals (Brown & Lent, 1996). Within the SCCT model (Lent et al., 1994; 2000), direct relationships are posed between person and contextual factors suggesting that cultural factors are linked to perceptions of the opportunity structure in which academic and career goals are framed. Moreover, contextual factors can facilitate the learning experiences that give rise to corresponding self and outcome beliefs. Bandura (1997) and Lent et al. (1994), however, asserted self-efficacy beliefs are especially important as they reflect core beliefs that one has the power to produce a desired effect through personal efforts. Thus, self-efficacy beliefs are also posited as informing outcome expectations.

Much of SCCT scholarship has focused on math/science-related variables. This scholarship reveals that math/science-related self-efficacy (i.e., academic and career) consistently figures prominently into the prediction of interest in STEM careers (Kahn & Nauta, 2001; Post, Stewart, & Smith, 1991; Schaefers, Epperson, & Nauta, 1997), choice of STEM major (Lent et al., 1986), and actual pursuit of STEM careers (Griffin, 1990). Math/science-related self-efficacy is indirectly associated with selection of and persistence in a STEM major through its relationship to math/science interests and goals (Lent, Brown, Schmidt et al., 2003).

Racial/ethnic disparities in efficacy beliefs have been speculated as contributing to lower persistence for ALANA students in STEM majors, owing partially to compromised self-beliefs from environmental challenges associated with being an ALANA individual in predominantly White contexts (Seymour & Hewitt, 1997). However, in a study of engineering undergraduates conducted by Lent et al. (2005), African American students reported higher math/science-related academic self-efficacy and interests, and more positive math/science outcome expectations and social supports than did White students. The African American student sample was primarily drawn from historically-Black universities which provide more culturally-supportive and ethnically-congruent campus environments compared to predominantly-White universities, possibly accounting for the observed differences in Lent et al.'s study. More SCCT research is needed with ALANA STEM students in other college contexts, like predominantly-White institutions, to examine the influence of proximal contextual factors like perceptions of campus climate on their academic goals. In contrast to a direct contextual factors-goals pathway proposed by SCCT (Lent et al., 1994), growing research supports Bandura's (1997) proposition of an indirect relationship between proximal contextual factors and goals, mediated through self-efficacy beliefs (Lent et al., 2001, 2003, 2005). We examine Bandura's proposition in this study.

Lent et al. (1994) encouraged cultural specification of the SCCT model, acknowledging that coming to terms and dealing with the implications of race and ethnicity in one's life is a significant task for many ALANA group members. For instance, in academic pursuits or tasks performed in White-dominated contexts where perceived social opportunities for support and success may be few, like STEM fields, other-group orientation may be especially useful for ALANA individuals in facilitating their comfort to interact with non-ALANA groups. Moreover, a positive ethnic identity may enhance the self-perceptions of ALANA individuals (Phinney & Rotheram, 1987). Ethnic variables are conceptualized as personal inputs within SCCT that indirectly influence self-efficacy and outcome expectations through learning experiences. Although Lent et al. discussed the utility of SCCT to guide inquiry into cultural influences on career development, they did not theoretically specify the role (and placement) of cultural variables within the SCCT model[1]. More conceptual and empirical work is needed to understand the mechanisms through which personal-cultural variables impact other SCCT

[1]We appreciate an anonymous reviewer for raising this issue.

variables (Byars-Winston, in press; Byars-Winston, 2006). We offer the following rationale for our conceptualization of ethnic identity and other-group orientation in the present study.

Within SCCT (Lent et al., 1994), contextual factors are viewed as environmental difference variables relating to features of the environment that can be appraised and perceived as a support, opportunity, or barrier such as career-related family expectations, gender role stereotyping, and cultural socialization processes. Person inputs are conceived as individual difference variables that capture paths thru which demographic factors, such as race, ethnicity, and gender which, along with contextual factors, indirectly influence self-efficacy and outcome expectations through learning experiences. In this vein, ethnic identity and other-group orientation result from the transaction between person inputs (i.e., one's ethnic group membership) and social or contextual inputs (e.g., ethnic socialization processes and inter-cultural experiences) and can be viewed as "psychosocial" inputs reflecting the link between personal demographics and proximal and distal opportunity structures in shaping attitudes toward one's ethnic group and others. Indeed, Lent et al. asserted that the significant influence of person inputs lies in the individual's social construction of experience related to a given heritable attribute (e.g., ethnicity, gender). Thus, we view ethnic identity and other-group orientation as person inputs that capture differences in individuals' conceptions of themselves as members of their ethnic group and their relations to others outside of their ethnic group.

A few studies have examined ethnic factors in relation to self-efficacy beliefs. Results from these studies reveal a positive, direct relationship between ethnic identity and other-group orientation and measures of math academic self-efficacy, career decision-making, and math course-taking for high school and college samples of ALANA students (Gloria & Hird, 1999; Gushue & Whitson, 2006; O'Brien, Martinez-Pons & Kopala, 1999; Rollins & Valdez, 2006). Only one study was identified examining ethnic identity in relation to math/science social cognitive variables (O'Brien et al.).

SCCT holds promise for investigating retention-related variables for ALANA students in that the theory permits simultaneous examination and integrated analyses of the processes by which perceived cognitive (e.g., efficacy and outcome expectations), cultural (e.g., ethnic identity), and contextual (e.g., perceived campus climate) factors relate to STEM degree goals. No research to date has examined these factors with ALANA STEM students using SCCT. Further, existing STEM research is predominated by studies of engineering students (Lent et al., 2005) with marginal attention to students in other STEM areas, including biological sciences. Some research indicates differences in factors that explain academic and career variables for women in engineering and biological sciences (Nauta, Epperson, & Kahn, 1998). Similarly, examining differences in pathways that inform STEM goals for ALANA students in biological science and engineering may reveal distinct relationships among cognitive, cultural, and contextual factors that are relevant to designing effective career and retention-focused interventions. This study sought to address these gaps in the literature and advance the scholarship on the academic development of students in STEM.

Purpose of the Study

The primary purpose of this study was to investigate the relationships of cognitive, contextual, and cultural factors to STEM interests and STEM degree goals in a sample of ALANA STEM students at a predominantly-White campus. Students' self-reported goal commitment to complete a STEM college degree was selected as the primary criterion variable given that SCCT (Lent et al., 1994) postulates behavioral outcomes are greatly informed by goals (e.g., intentions, plans, commitment to realize a particular academic or career outcome).

We tested several hypotheses in accordance with SCCT propositions and based on extant research with diverse ethnic groups reviewed herein; the hypothesized model is illustrated in

Figure 1. First, based on previous research (Gloria & Hird, 1999;Gushue & Whitson, 2006;O'Brien et al., 1999), we hypothesized that the person input variables of ethnic identity and other-group orientation would have direct, positive relationships to math/science academic self-efficacy and math/science outcome expectations (paths 1 – 4). Second, a positive relationship from self-efficacy to outcome expectations was hypothesized given that SCCT proposes that the former construct partially informs the latter construct (path 5). Third, both self-efficacy and outcome expectations were posited to directly relate to interests (paths 6 and 7) and goals (paths 9 and 10) with partial mediation through interests (path 8). Based on SCCT theory and previous research, interests were expected to account for the largest amount of variance in STEM degree goals. Finally, we hypothesized that the proximal contextual factor of perceived campus climate would indirectly relate to goals through three paths: through self-efficacy (path 11) consistent with prior research supporting this indirect path (Lent et al., 2001,2003,2005), through ethnic identity (path 12), and through other-group orientation (path 13) based on SCCT's assertion of a direct relation between person and contextual factors. Given that differences in the pathways through which social cognitive variables contribute to career outcomes have been observed between engineering and biological science students (Nauta et al., 1998), another purpose of this study was to investigate the fit of the hypothesized path model across the engineering and biological science samples.

Method

Participants

Undergraduate ALANA students pursuing majors in two colleges, engineering (E) and life sciences (S), at a major Midwestern research-intensive university were invited to participate in the study. At this university, approximately 8% of the total undergraduate student population is ALANA; about 7% in college S and about 5% in college E are ALANA undergraduate students. College S consists of biological and agricultural sciences (i.e., applied biology) and offers 25 undergraduate majors including biology, genetics, microbiology, animal science, biochemistry, nutritional sciences/dietetics, plant pathology, botany, bacteriology, entomology, wildlife ecology, and zoology. These majors are consistent with those included as "biological sciences" in previous research (Nauta et al., 1998). College E offers 13 undergraduate majors in traditional areas like electrical, civil, computer, mechanical, engineering mechanics/astronautics as well as biomedical engineering and biological systems engineering.

During the academic terms in which participant recruitment occurred, there were on average 350 students (~150 in engineering, ~200 in science) who met the inclusion criteria. Accordingly, the approximate response rate was 64%, with 223 students completing the survey. The sample included men (n = 117) and women (n = 104) (2 did not report gender) and represented both colleges relatively evenly (S: n = 109; E: n = 114). They ranged in age from 18 to 39, with a mean age of 20. Participants' academic class standing included: 34% freshmen, 21% sophomores, 20% juniors, and 25% seniors. The most frequently reported majors in college S were biology (n = 32) and genetics (n = 13) and in college E were mechanical (n = 23), electrical (n = 17), and biomedical (n = 15) engineering.

Participants self-identified as Black or African-American (n = 55), Hispanic or Latino/a (n = 62), Southeast Asian (n = 49), Native American (n = 8), or Bicultural (n = 48) (1 did not report race/ethnicity). Sub-group ethnicities for the 49 participants identifying as Southeast Asian were reported as follows: 19 = Vietnamese; 15 = Hmong; 2 = Cambodian; 2 = Thai; 1 = Lao; and 10 only indicated Southeast Asian without a specific ethnicity. Among the 62 participants endorsing Hispanic or Latino/a, 17 specified Mexican-American or Chicano/a ethnicity.

Procedure

Students were at least 18 years old so that they could personally consent to the study. The participant pool consisted of students identified by university administration as members of a targeted minority ethnic or racial group (i.e., ALANA). Administrators provided members of the study's research team with a list of these students' names and email addresses for participant recruitment. After approval was obtained from the university's institutional review board, participants were recruited through email that provided a link to an online version of the study survey which presented the measures in randomized order. These emails were sent by both research team members and administrators from the two participating colleges. Follow-up phone calls were made to students who received direct email invitations requesting that they complete the online survey. Participants were also recruited via direct solicitation during student organization meetings held in both colleges. During these meetings, paper copies of the survey were distributed and those students unable to complete the survey at that time were directed to the web address for the online survey. The survey took approximately 20 minutes to complete and for compensation of their time, participants were each given a $5 gift card and their names were entered into a raffle to win additional prizes (e.g., theatre tickets, book tuition certificates).

Instruments

The survey packet included an informed consent sheet, a demographic form (including information on participants' gender, race/ethnicity, age, year in school, and selected major), and measures of science, math, and engineering-related constructs. Racial/ethnic categories were listed on the demographic form of the survey for participants to endorse as well as blank space for racial/ethnic specification not otherwise provided. These categories included: Black or African-American; Pacific-Islander; American Indian; Asian-American with space provided to specify Asian ethnic heritage; Hispanic or Latino/a with space provided to specify Hispanic or Latino ethnic heritage; White, Caucasian, European, Not Hispanic; and Bicultural. Participants endorsing the "bicultural" category were instructed to indicate the racial/ethnic heritage of both parents; only those with at least one parent considered ALANA were included in the study. The science, math, and engineering measures were selected based on their validity in previous SCCT research with engineering students (Lent et al., 2001; Lent et al., 1986; Lent, Lopez, & Bieschke, 1991; Lopez & Lent, 1992). All engineering students take physics, calculus, and chemistry courses thus the math and science item content were considered to be relevant to them as well as to those students pursuing biological science majors.

Academic Self-Efficacy—Lent et al.'s (1986, 1987) Self-Efficacy for Academic Milestones index was used to measure students' confidence in their ability to complete specific tasks relevant to success in science and engineering majors. The original 11-item scale was adapted by the first author of the current study in two ways. First, we wanted the scale to be applicable to both biological science and engineering majors, since Lent et al.'s original scale only targeted engineering majors. Thus, we modified the items to assess students' confidence to perform a given task for science, agriculture, or engineering majors (e.g., "complete the mathematics requirements for most science, agriculture, or engineering majors") and we added an item related to completing the "biological requirements for most science, agriculture, or engineering majors" to be relevant to biological science majors as well as biomedical engineering. Second, Lent et al.'s original scale included an item assessing students' confidence to perform competently in an engineering career field. We excluded this item from the scale as we were only interested in assessing students' confidence to perform well at academic tasks and not post-degree pursuits. Thus, the modified self-efficacy for academic milestones scale was also comprised of 11 items. In modifying this measure, we followed the same practice used in Lent et al. (2003, 2005) and Nauta et al. (1997) wherein the self-efficacy measures were adapted from the earlier Lent et al. (1986) scales to the current study.

For each item, confidence ratings were obtained on a 10-point Likert-type scale ranging from 0 (*no confidence*) to 9 (*complete confidence*), indicating the degree to which participants felt they could accomplish each academic milestone. Mean scale scores were calculated on this measure with higher values indicating greater confidence to successfully perform a variety of academic tasks. A Spearman-Brown split-half reliability coefficient of .85 was achieved for this modified measure and a Cronbach's alpha coefficient of .92 was achieved for the full scale with the current sample; this alpha coefficient is similar to those previously reported for the original scale (Lent et al., 1986, 1987). In terms of validity, scores on the modified academic self-efficacy measure were related to scores on the interests measure in theory-consistent directions similar to validity evidence reported for the original measure (Lent et al.). Support was also found for criterion validity in that academic self-efficacy scores were positively related to participants' reported commitment to their college major in the current study.

Outcome Expectations—Outcome expectations were assessed by an 18-item measure of participants' expectations about the consequences of obtaining a college degree. The scale, adapted from Lent et al.'s (2001) outcome expectations measure, assessed students' value of math/science educational attainment to their future career and life plans and included outcomes that were both positive (e.g., "Getting a degree in a math or science-related field would allow me to earn a good salary") and negative (e.g., "In terms of my adult life, it is not important for me to do well in mathematics"). The negatively worded items were reverse scored so that higher scores indicate positive beliefs about the relevance of a math/science degree to positive life outcomes. Lent et al.'s original 15-item measure tapped two of the three types of outcome expectations: physical (e.g., monetary) and self-evaluative (e.g., personal satisfaction from achieving outcome) (Bandura, 1997). We added three items relating to the third type of outcome expectations, anticipated social outcomes (e.g., approval or respect from valued others) stemming from earning a math/science degree (e.g., "My friends would admire me if I were to earn a degree in a math or science-related field"). Responses were made on a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Mean scale scores were calculated for this measure. Evidence of validity was supported by a positive a relationship between outcome expectations and academic self-efficacy consistent with SCCT theory. Lent et al. reported a coefficient alpha of .89 for the original 15-item measure; a coefficient alpha of .85 was found in the present study for the modified 18-item version.

Interests—Participants' STEM interests were assessed using a seven item scale developed by Lent et al. (2003) that measures participants' degree of interest in participating in seven math/science activities (e.g., "working on a problem involving scientific concepts"). Participants indicated their degree of interest in each item using a 5-point scale ranging from 1 (*strongly dislike*) to 5 (*strongly like*). A mean total scale score was calculated for the measure and higher scores indicate stronger interest in math/science-related activities. Extensive validity support for this measure has been reported by Lent and his colleagues (2003, 2005) indicating that math/science interests are associated with relevant academic self-efficacy, outcome expectations, and prior math achievement. Internal reliability coefficients of .80 and .83 have been reported for this measure; a Cronbach's alpha coefficient of .79 was found with the present sample.

Perceptions of Campus Climate—Perceptions of campus climate (PCC) were measured using three subscales totaling 15-items developed by Cabrera, Nora, Terenzini, Pascarella and Hagedorn (1999) of student adjustment and perceptions of campus climate in explaining student persistence. The item content is conceptually based in Pascarella and Terenzini's (1980) model of college attrition. These subscales have been used widely in the student development and college persistence literature and recently adapted to measure perceived campus climate with African American STEM students (Brown et al., 2005). The PCC item content taps the social domain identified as critical to ALANA student retention such as classroom experiences, interactions with other students, and perceptions of prejudice and discrimination (Cabrera et al., 2001).

Specifically, the subscales gauge participants' perceptions of social comfort or fit with the campus environment across several three social domains: classroom experiences (n = 7 items: e.g., "I feel safe and comfortable in the classroom"), racism and discrimination (n = 6 items: e.g., "I have encountered racism while attending this institution"), and peer interactions (n = 9: e.g., "It has been easy for me to meet and make friends with other students at my institution"). The 22 items are based on Brown et al.'s (2005) adaptation of Cabrera et al.'s (1999) three subscales worded to be relevant to STEM students. Two items in the classroom experiences subscale and six items in the peer interactions subscale were excluded from the survey as they assessed experiences related to perceptions of academic, not social, content (e.g., "My classes adequately prepare me for future courses related to the subject matter") or the impact of interpersonal relationships on personal and intellectual growth (e.g., "The student friendships I have developed have had a positive influence on my personal growth and interest in ideas"). One item ("I feel safe and comfortable in lab") was added to assess small group interactions in science and engineering (Terenzini, Cabrera, Colbeck, Bjorklund, & Parente, 2001).

Responses to the PCC are made on a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) with higher scores indicating more favorable perceptions of campus climate. A mean total PCC score was calculated and used for the present study as our interest was in the overall perception of campus climate, general campus and specific classroom experiences included, not in testing differential relations between these two levels of climate perceptions. Support for the validity of the PCC items as indicators of perceived discrimination, peer interactions, and classroom experiences exists in research conducted by Cabrera and associates (Brown et al, 2005; Cabrera, Castañeda, Nora, & Hengstler, 1992; Cabrera et al., 1999, 2001; Nora & Cabrera, 1996) and Brown et al. (2005). Reliability coefficients for Cabrera et al.'s subscales have been reported between .85 and .87 (cf. Nora & Cabrera). Cronbach's alpha coefficient of .89 was achieved with the current sample for the total 15-item PCC measure.

STEM Degree Goals—Participants' goals to complete a STEM degree were assessed using a single item for goal commitment (i.e., "It is important for me to finish my program of studies") which has been used in national samples examining ALANA student persistence in general and with STEM populations (Brown et al., 2005; Cabrera et al., 1999). Our construct of interest was relatively unidimensional, narrowly-defined, uncomplicated and clear to participants—goal to complete a STEM degree, thus making a single-item measure appropriate for use (Sackett & Larson, 1990). In line with Gardner, Cummings, Dunham and Pierce's recommendation (1998), a "good" single item of the construct of interest was deemed sufficient compared to a sum of responses to multiple specific items of the same construct, which also helps to reduce participant fatigue in responding to redundant items assessing the same construct when face validity is evident.

We modified the degree goal statement to read, "It is important for me to finish my program of studies in science or engineering." Responses to the statement are made on a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) such that higher scores indicate stronger commitment to a STEM degree. Support for validity was indicated by its relationship to positive academic and social experiences in a multi-ethnic sample (cf. Cabrera et al., Cabrera, Nora, & Castañeda 1993).

Ethnic Identity and Other-Group Orientation—Roberts, Phinney, Masse, et al.'s (1999) revised version of the Multigroup Ethnic Identity Measure (MEIM; Phinney, 1992) was used to assess ethnic identity and other-group orientation. The ethnic identity scale consists of 12 items that measure participants' ethnic attitudes across three dimensions sense of belonging, exploration of one's identity and ethnic practices (e.g., "I feel a strong attachment towards my own ethnic group"). Another six items separately measure other-group orientation (OGO) assessing participants' attitudes toward inter-ethnic group contact (e.g., "I enjoy being around people from ethnic groups other than my own"). Participants responded to the items on a 4-point Likert scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). Negatively worded items (e.g., "I don't try to become friends with people from other ethnic groups") were reverse scored so that higher scores indicate positive attitudes toward one's in-group (ethnic identity) or out-group (OGO). Mean scale scores were calculated for ethnic identity and OGO.

Recent research supports the construct validity of this 18-item revised MEIM with ethnically diverse college populations (Avery et al., 2007). Reliability estimates for the MEIM ethnic identity scale have ranged between .86 - .90 and reliability estimates for the OGO scale have ranged between .65 and .87 with ethnically diverse samples (Avery et al.; Guzmán, Santiago-Rivera & Haase, 2005; Roberts et al., 1999; Worrell, 2007). Cronbach's alpha coefficients of .88 for Ethnic ID and .68 for OGO were achieved in the current sample.

Data Analysis and Goodness of Fit Criteria

LISREL 8.71 (Joreskog & Sorbom, 2004) software was used to test the hypothesized path model with the raw data imported from SPSS (version 15). The Comparative Fit Index (CFI) and chi-square statistic were used in evaluating the analyses. In addition to the CFI, the root mean square error of approximation (RMSEA) and the standardized root mean-square residual (SRMR) were used as indicators of model fit in accordance with Hu and Bentler's (1999) suggested combinational rule. Hu and Bentler recommended the combined used of these multiple fit indices in addition to the chi-square likelihood statistic given that the latter is sensitive to sample size and provides information only for a dichotomous decision (i.e., accept or reject the null hypothesis). A nonsignificant chi-square value is desired indicating that the observed data fit the hypothesized model.

In evaluating the overall goodness-of-fit criteria for the path models, CFI values greater than .90, RMSEA values around .06, and SRMR values less than .05 generally provide statistical support that a model explains the data within a small degree of error (Quintana & Maxwell, 1999; Tabachnick & Fidell, 1996). However, RMSEA tends to overreject true population models (Type II error) in smaller samples (e.g., $N = \leq 250$) and is, thus, generally less preferable (Hu & Bentler, 1999). Therefore, we used the ratio between chi-square and its degree of freedom as an additional benchmark for model endorsement (Byrne, 1994), given that the higher the chi-square statistic, the higher the probability of a misspecified model. In a true model, the expected value of the chi-square statistic is equal to the degrees of freedom, and does not systematically vary across sample size (Tucker & Lewis, 1973). A chi-square to degrees of freedom ratio ≤ 2 indicates reasonable model fit.

Ding, Velicer, and Harlow's (1995) review of several studies indicated that 100 to 150 participants is the minimum sample size for performing structural equation models. A saturated model (with all parameters indicated) with p variables has $p(p + 1)/2$ free parameters to be estimated (Bentler, 2006). In the present study with 6 observed variables, there were $6(6+1)/2 = 21$ free parameters. The sample size in the present study was consistent with Bentler and Chou's (1987) suggested ratio of 5 subjects per estimated parameter ($21 \times 5 = 105$).

Results

Preliminary Analyses

The data were screened for missing values and normality. Using the multiple imputation feature in SPSS, analysis of the patterns of missing data revealed six of the seven variables had at least one missing value on a case. Only 4 of the 223 cases had at least one missing variable, translating to 11 of the total 1,550 values missing. Results of Little's missing completely at random test using the EM estimation method resulted in an insignificant chi-square statistic (χ^2= 22.863, *df* = 14, *p* = .06). We then ran an automatic imputation with fully conditional specification modeled with a linear regression. Positive values were imputed for all scale variables. The mean values for imputations were nearly identical to the mean for the original data. Inspection of the skewness values of the data indicated that academic self-efficacy, other-group orientation, and goals were negatively skewed. To guard against underestimation of variance due to non-normality, model estimation proceeded using normal theory estimators with robust methods and the Satorra-Bentler chi-square (SB χ^2) statistic.

A multivariate analysis of variance was performed on the six predictor and one criterion variables to examine mean differences by college. A significant effect for college was found [F (7, 215) =5.24, $p < .00$, λ =.85, η^2 =.15] indicating that participants from engineering reported higher academic self-efficacy, interest in math/science activities, outcome expectations, and more positive perceptions of campus climate than did participants from biological sciences (Table 1, imputed values reported). The effect sizes, however, were relatively modest indicated by the range of partial eta-squared values (η^2 =.03 – .07). The zero-order correlations of the study variables are presented in Table 2. Since ethnic identity was not significantly associated with perceived campus climate, self-efficacy, or outcome expectations as hypothesized, it was not included in the hypothesized path model tested.

Multiple-Group Analysis

We fit a hypothesized path model to the covariance matrices of two groups, engineering and biological science students. Figure 2 illustrates the path model tested (Ethnic Identity omitted) based upon SCCT propositions in Lent et al. (1994) and other research literature reviewed herein. All models were fit using robust maximum likelihood (RML) in LISREL as it performs well across various sample sizes and to account for the apparent non-normality of some variables. Initially, we assumed that the groups might display different effects and thus proceeded from a least restrictive (fully unconstrained) to most restrictive (fully constrained) model in terms of constraints on the parameters. Fit indices are reported in Table 3 for the fully unconstrained, partially constrained, and fully constrained models. Reasonably good fit statistics were observed in the unconstrained model where all paths were freed to vary across groups (SB χ^2 = 14.49, *df* = 10, *p* =.16). Results indicated that this hypothesized model had a good approximation to the observed data and that a common path model could be assumed across groups. The CFI = .97 value and chi-square/*df* ratio of less than 2 provided additional support that the model fit the data well.

Next, we proceeded to test whether further restrictions could be added to the model to make it more parsimonious and improve fit statistics. We performed χ^2 difference tests for each path by comparing the previous model tested to one in which a path was constrained to invariance across groups. In this way, a series of models were compared wherein each path was constrained to equality, one at a time, between the groups. The change in chi-square between the fully unconstrained and fully constrained models ($\Delta\ \chi^2$ = 13.88, *df* = 10, *p* = .18) was insignificant. A subsequent model was fit in which all paths were constrained to invariance except the paths found to differ significantly across groups, the academic self-efficacy to goals path and the interests to goals path. This partially constrained model also provided very good overall model

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fit (SB χ^2 = 20.76, *df* = 18, *p* = .29), CFI = .98, and due to its great parsimony was chosen as the final model for the interpretation of effects. The chi-square tests for differences in path coefficients for the partially constrained model in which only two paths were allowed to vary across groups are reported in Table 4. The change in chi-square between the unconstrained and partially constrained models was insignificant, $\Delta \chi^2$ = 7.55, *df* = 8, *p* = .48), indicating no detectable difference in the model in which all but two paths were constrained to equality across groups.

In this final model, all paths were significant ($p < .05$) except for three. The standardized regression path coefficients for the two groups are displayed in Figure 2 for ease of interpretation, which illustrates the partially constrained model in which only two paths were allowed to vary across the groups. The path coefficient values were equal in all but two paths, for which the two values that differed between the engineering and biological science groups are reported in Figure 2. The first hypothesis, posing direct paths from the ethnic variables (Ethnic Identity and OGO) to self-efficacy and outcome expectations was partially supported. Whereas OGO was related to self-efficacy only (paths 1 and 2), Ethnic Identity was not related to either variable. The second hypothesis was supported with a positive association from self-efficacy to outcome expectations (path 3). The proportion of variance explained in outcome expectations for students in biological science was 7% and 5% for students in engineering. The third hypothesis was supported for the direct effects of self-efficacy and outcome expectations on interests (paths 4 and 5), accounting for 17% and 13% of the interests variance in the biological science and engineering groups, respectively.

Although outcome expectations directly contributed to STEM degree goals for both the engineering and biological science groups (path 7), academic self-efficacy contributed to goals only for the biological science sample (path 8). A significant relationship was found between interests and goals only for the engineering sample (path 6). The proportion of goals variance explained for the biological science group was 21% and 16% for the engineering group. The last hypothesis was partially supported for an indirect effect of perceived campus climate on goals mediated by self-efficacy and OGO (paths 9, 10); no relationship emerged between ethnic identity and perceived campus climate. The proportion of explained variance in academic self-efficacy for the biological science group was 13% and 15% for the engineering group; 7% and 6% of the OGO variance for biological science students and engineering students, respectively, was accounted for by perceived campus climate.

Discussion

This study tested a hypothesized model of relationships among social cognitive, cultural and contextual factors in relation to STEM degree goals with a sample of ALANA students in engineering and biological science majors. Results of the study were largely consistent with SCCT (Lent et al., 1994) propositions, indicating that math/science-related academic self-efficacy and outcome expectations were associated with academic goals. Additionally, this study provided preliminary evidence regarding the relevance of cultural and contextual factors to the academic goals of ALANA students in STEM. Several findings are discussed along with applications to practice and implications for future research.

First, congruous with SCCT propositions direct relationships were found between academic self-efficacy and outcome expectations to interests and goals, although this varied by group. These findings indicate that participants who perceived themselves to be efficacious in and anticipate positive rewards from math/science pursuits also expressed STEM interests and goals to complete a STEM degree. The path coefficients (Figure 2, paths 5 and 8) for outcome expectations to interests and goals were the same for both ALANA engineering and biological science students. It appears that the independent contribution of outcome expectations to goals

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in this study is due partly to the facilitative path from self-efficacy to outcome expectations. Thus, the physical, social and self-evaluative consequences believed to flow from math/science goal attainment independently foster interests in and goals toward earning a STEM degree, enhanced by the indirect effect of math/science self-efficacy beliefs. The significant path from outcome expectations to interests and goals may also reflect participants' pragmatic orientation toward STEM pursuits. Indeed, the job prospects, prestige, and pay are comparatively good for STEM workers than in other fields (NSB, 2008), with the STEM workforce growth rates and salaries exceeding those in the general labor force.

Second, and notable in this study, two pathways were found to differ between the groups. The path coefficient for academic self-efficacy to goals (Figure 2, path 7) was only significant for the biological sciences group. This finding suggests that for biological science students, the contribution of self-efficacy to goals is both direct and indirect, partially mediated through outcome expectations. Social cognitive theorists (Bandura, 1997;Lent et al., 1994) assert that to the extent that a given outcome is based primarily on the adequacy of one's behavior, efficacy beliefs exert more influence on academic and career goals and behavior. The significant efficacy-goals relationship may reflect this group's belief in a direct link between their performance and degree attainment, such that the perceived likelihood of success (degree attainment) is high in biological science. The fact that this path also had the largest coefficient (in absolute value) in the model is consistent with Bandura's (1986) assertion that efficacy beliefs generally account for the lion's share of influence on interest and choice goals development.

For engineering students, however, the contribution of academic self-efficacy to goals is only indirect, mediated through outcome expectations and interests (Figure 2, path 6). The significant path from interests to goals for this group may reflect Lent et al.'s (1994) proposition that the relation between these two variables will be stronger for individuals who perceive favorable environmental conditions and opportunities to translate their interests into choice goals. More than 50 engineering student organizations exist in the university sampled, with 8 programs and affinity groups serving ALANA students within the engineering college. Approximately 10 student organizations exist campuswide for biological science with 1 affinity group for ALANA students in the life science college. Thus, the interests-goals pathway for engineering students may have captured the influence of other factors not measured for this study, like perceived academic and social supports or encouragement from faculty and staff, which can facilitate the academic goals of ALANA groups particularly in STEM fields (Lent et al., 2005). This interpretation, however, is based on indirect evidence as we did not explicitly measure perceived environmental support. Whether perceived supports moderate the interest-goal relations for ALANA STEM students is an important direction for future research.

We note that the nonsignificant interests-goals path for biological science students does not necessarily suggest that they perceive less support to realize their STEM degree goals as a function of their interests. Perhaps interests in other domains besides math/science activities inform the goals of this group. For instance, in a qualitative study African American students' pursuit of science majors was influenced by their interests in doing work that they perceived would make a direct contribution to their ethnic group communities (e.g., research that addresses a health disparity) (Lewis & Collins, 2001). It is also possible that the nonsignicant relationship between interests and goals for biological science students is a result of the measure used. Other measures of math/science interests that have been used in SCCT studies (Gainor & Lent, 1998; Lent et al., 2001) may yield different results.

Third, our hypothesis was partially supported that ethnic factors would be associated with math/science-related academic self-efficacy and outcome expectations. Contrary to previous research, ethnic identity was not significantly associated with perceived campus climate, self-efficacy, and outcome expectations. It may be that direct relations may be found between ethnic identity and learning experiences, i.e., sources of efficacy information, that give rise to efficacy and outcome expectancies. Only other-group orientation (OGO) contributed unique variance to self-efficacy in the path model tested. Prior research has revealed a similar relationship showing an association between OGO and career decision-making self-efficacy for ALANA students (Gloria & Hird, 1999). The current findings suggest that to the extent ALANA students are comfortable interacting with others outside of their personal ethnic group, they feel more confident in their academic STEM pursuits. The significance of OGO may owe in part to the cultural context of the university sampled, in which ALANA students' ethnic minority status is acutely evident in colleges of engineering and biological science. Important to note is that the OGO-self-efficacy path fit equally well for both groups, perhaps because ALANA groups are similarly underrepresented in these fields. In 2006–2007, African Americans, Latino/as, and Native Americans (no educational data by degree field reported for Southeast Asians) in the U.S. earned far fewer bachelor's degrees across all fields than White individuals (18% vs. 72%); they received 15% of biology degrees and 11% of engineering degrees (Digest of Education Statistics, 2008). Although relative gender parity is more evident in biological sciences compared to engineering (Fassinger, 2008), racial and ethnic equity remains a challenge in both biological sciences and engineering. Thus, ALANA students' comfort and negotiation with others outside of their ethnic group appears to be especially functional to successful pursuit of STEM degrees.

The relationship between OGO and academic self-efficacy illustrates the benefit of a bicultural orientation in relation to achieving a STEM degree in a predominantly-White context. It may be that cross-ethnic engagement facilitates acquisition of bicultural competence, practicing and honing behavioral skill sets that increase the individual's adeptness in multiple environments. Guzmán et al. (2005) found that Mexican American students who had higher OGO scores also reported positive attitudes toward education and school. A bicultural orientation may mean that ALANA students in this study are exposed to and observe a wider range of people succeeding in STEM pursuits which may increase their social supports, networks, and resources that then fuel their perceived ability to earn a STEM degree. Future research may investigate factors that inform OGO and its relationship to other SCCT variables, like math/science coping efficacy (perceived ability to cope with challenges in pursuing a STEM major), to further clarify its contribution to STEM-related academic and career outcomes.

Taken together, the current findings indicate that OGO indirectly contributes to math/science interests and goals through self-efficacy beliefs for ALANA STEM students. These results highlight the importance of considering and addressing ALANA students' interethnic contact and comfort as they pursue STEM majors, especially given their significant numerical minority status within these disciplines. Further examination into how cultural factors inform STEM goals for ALANA students in different contexts (e.g., minority-serving institutions) is needed to clarify these pathways. For ALANA STEM students at predominantly-White institutions, positive inter-ethnic interactions with others (e.g., peers, staff, faculty) is an academic asset.

Finally, this study supported the hypothesized efficacy-mediated effects of perceived campus climate on academic goals. ALANA STEM students who are academically confident perceive a more positive campus climate than those who are not academically confident. It may be that those with high efficacy beliefs are more likely to appraise their environments positively in general given their expectations for personal success. Conversely, it may be that perceived positive environments enhance individuals' sense of competence, and thus a bidirectional relationship cannot be ruled out. From a social cognitive view, a resilient sense of one's abilities regulates one's functioning within and appraisal of social systems. Individuals with a high sense of efficacy accept various environmental conditions that may facilitate or interfere with their efforts (Bandura, 1997) and sustain needed efforts toward their academic pursuits. To be sure, a strong sense of efficacy is vital for successful adaptation to social contexts. Such adaptation is important for ALANA students who often contend with unwelcoming campus environments, especially within STEM disciplines (Seymour & Hewitt, 1997). This may explain why self-efficacy and OGO jointly mediated the effect of perceived campus climate, with OGO functioning as an index of students' cultural adaptation. Helping students sustain their academic confidence and have positive inter-ethnic interactions may enhance their perceptions of comfort and fit within the campus context. More research is needed into the relationship of proximal contextual factors, like perceived campus climate, to other SCCT variables including supports and barriers for ALANA STEM students.

There are several limitations to this study. First, this was a preliminary study and thus cautious interpretations of the results are warranted. For instance, the fit of the path model tested herein may vary between racial/ethnic groups or across class standing (i.e., less vs. more advanced students) in STEM. Future studies conducted with other samples and that consider potential academic year or racial/ethnic group differences will help validate the current findings and uncover nuances in the relevance of cultural, cognitive, and contextual factors to their STEM pursuits. Second, the study's sample was drawn from a selective, research-intensive institution wherein the larger ALANA student population of STEM majors from which this sample was drawn includes academically high-achieving students with high persistence rates in STEM. Not surprisingly given their personal success histories in STEM and college overall, this sample reported high academic self-efficacy and STEM degree goals. Diverse samples from other college contexts (e.g., non research-intensive) may yield different results. Third, this study employed a cross-sectional research design using self-report data and thus the predictive nature of variables' relationships cannot be established. Studies employing longitudinal research design are needed to identify when and how cognitive, cultural, and contextual variables predict eventual academic and career outcomes. For example, at what point in students' academic and career development is OGO relevant to self-efficacy and outcome expectations? Finally, methodological limitations include the use of a single item to assess goal outcomes and modified instruments for which psychometric data are unavailable from other samples.

Several counseling implications are implied from the present research. Overall, this study's findings suggest that for this sample of ALANA STEM students, primarily academic self-efficacy and outcome expectations contribute to their self-regulation toward goal attainment. Given that outcome expectations are partially derived from self-efficacy, it is likely that bolstering efficacy beliefs will have a positive, dual effect on strengthening the academic interests and goals of ALANA students in STEM majors. Support exists for the effectiveness of SCCT-informed interventions using the four sources of efficacy information, such as vicarious learning and verbal persuasion, in increasing self-efficacy beliefs (Chronister & McWhirter, 2005; Sullivan & Mahalik, 2000). Counselors might examine the impact of such interventions on self-efficacy and outcome expectations (Fouad & Guillen, 2006) as well as conduct research to identify the factors that give rise to these expectations for ALANA STEM students.

Further, in light of the contribution of OGO to self-efficacy and its mediating role for perceived campus climate, counselors may consider strategies for supporting ALANA STEM students' comfort interacting with others outside of their ethnic group. Following LaFromboise and Rowe's (1983) bicultural skills training program, counselors might use behavioral rehearsal and modeling techniques to develop and sustain students' bicultural competence. Thompson and Sekaquaptewa (2002) discussed the value of individuals with solo status, or who are one of very few representatives of their social group, forming a "common ingroup identity" with majority groups. Accordingly, counselors working with ALANA STEM students may explore ways to emphasize ALANAs' shared identity of being a STEM major with other STEM students, regardless of ethnicity, and identify ways in which they might develop or draw on supports from diverse individuals to achieve their academic goals (Byars-Winston, in press).

In summary, our findings suggest that the SCCT model can increase our understanding of the academic interests and goals of ALANA students in STEM majors, an important population more often conceptually and anecdotally discussed but less often empirically examined in STEM scholarship. The results of the present study indicate that retention efforts with ALANA STEM students might do well to address their math/science-related academic efficacy beliefs, outcome expectations, inter-ethnic interactions, as well as their social perceptions of campus. This study adds to the research base applying SCCT to STEM disciplines by including ALANA students in both engineering and biological sciences. The differences found between the two groups warrant continued investigations into the shared and distinct dimensions of their academic and career-related experiences. Lastly, these findings may guide tests of the effectiveness of theoretically-driven interventions applying SCCT to ALANA STEM students.

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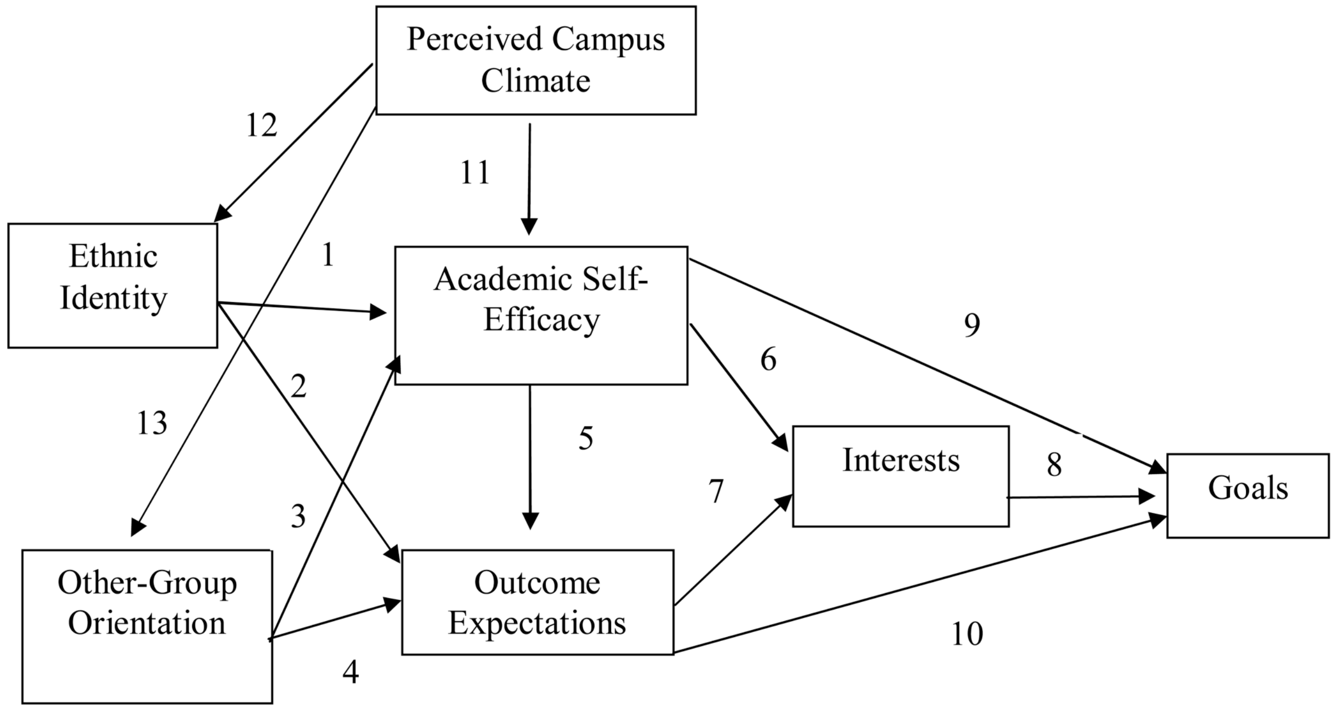

Figure 1.
Theorized SCCT relationships with ethnic identity.

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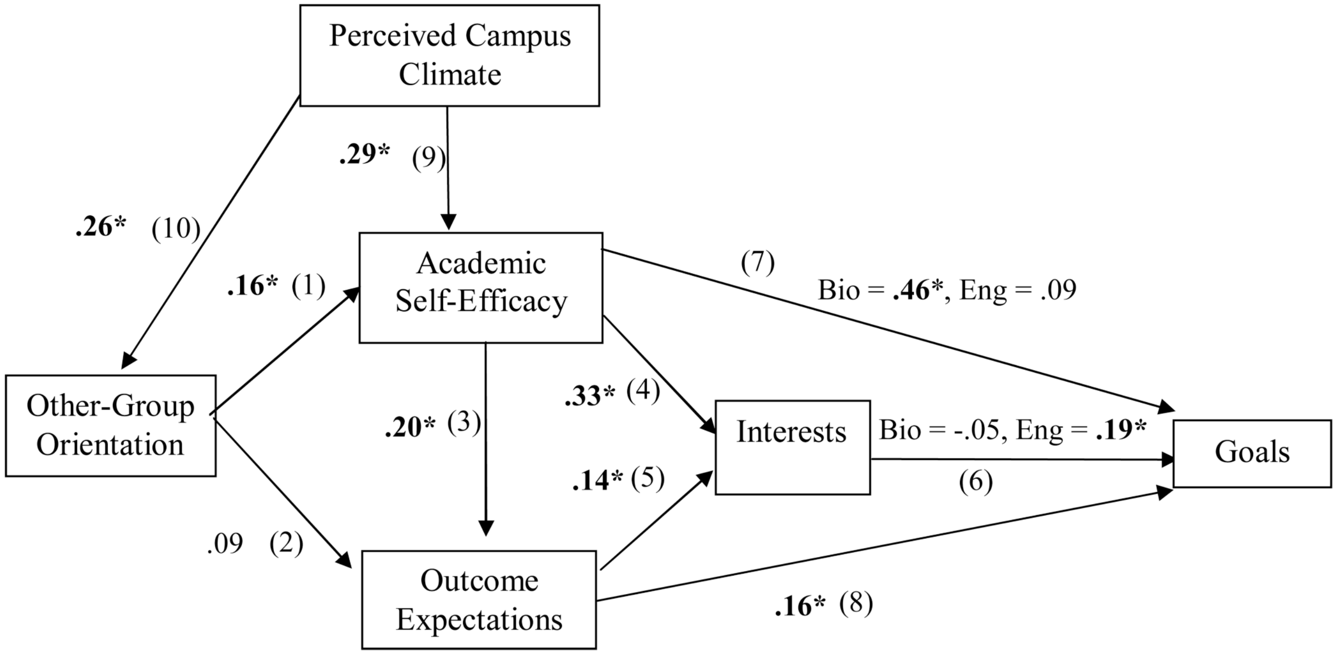

Figure 2.

Modified SCCT relationships tested in path model without ethnic identity.

Note: Path coefficients (i.e., standardized regression weights) appear outside parentheses; individual path numbers appear inside parentheses. Significant paths are indicated with an “*” and appear in bold font. Bio = Biological Sciences; Eng = Engineering.

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Table 1

Study Variables for Total Sample and by College

Variables	Total Sample		Engineering		Biological Sciences			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F (1,221)*	η^2
1. Academic Self-Efficacy	7.40	1.50	7.18	1.61	7.64	1.33	5.58*	.025
2. Outcome Expectations	4.00	0.59	3.85	0.55	4.12	0.59	12.13**	.052
3. Interests	3.63	0.70	3.43	0.66	3.82	0.68	18.38***	.077
4. Goals	4.70	0.73	4.62	0.88	4.77	0.55	2.52	.011
5. Perceived Campus Climate	3.74	0.65	3.60	0.69	3.86	0.59	9.02**	.039
6.Ethnic Identity	3.13	0.55	3.20	0.54	3.06	0.55	3.35	.015
7.Other-Group Orientation	3.56	0.42	3.57	0.44	3.55	0.40	.14	.001

Table 2

Correlations Between Variables By School

		Biological Sciences						
	Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	1. Academic Self-Efficacy	-	.22*	.33**	.18	.15	.06	.06
Engineering	2.Outcome Expectations	.14	-	.19*	.30**	−.02	.14	.12
	3. Interests	.33**	.23*	-	.12	−.09	.08	.04
	4. Goals	.31**	.25**	.35**	-	.12	.10	.10
	5.Perceived Campus Climate	.23**	.30**	.36**	.16	-	−.14	.23*
	6. Ethnic Identity	−.02	.15	.01	.04	.00	-	.13
	7. OGO	.12	.17	.22*	.16	.28**	.03	-

Note: OGO = Other-group orientation.

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Table 3

Summary of Fit Statistics for Hypothesized Path Model

Model	χ^2	*df*	*p*	CFI	SRMR	RMSEA	Chi square/ *df* ratio
Paths Fully Unconstrained	14.49	10	.16	.97	.04, .06	.06	1.45
Paths Partially Constrained	20.76	18	.29	.98	.07, .10	.04	1.15
Paths Fully Constrained	28.37	20	.10	.95	.08, .09	.06	1.42

Note: N = 223. CFI = comparative fit index; SRMR = standardized root mean square residual for both groups; RMSEA = root mean square error of approximation.

Table 4

Chi-Square Differences Tests from Multiple-Groups Model

Path	$\chi^2(1)$	*p* - value
1. Other-Group Orientation to Academic Self-Efficacy	.48	.49
2. Other-Group Orientation to Outcome Expectations	.27	.60
3. Academic Self-Efficacy to Outcome Expectations	.08	.78
4. Academic Self-Efficacy to Interests	3.44	.06
5. Outcome Expectations to Interests	.00	>.99
6. Interests to Goals	4.02	.04
7. Academic Self-Efficacy to Goals	6.73	.01
8. Outcome Expectations to Goals	1.59	.21
9. Perceived Campus Climate to Academic Self-Efficacy	1.45	.29
10. Perceived Campus Climate to Other-Group Orientation	.29	.59