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Social cognitive predictors of Latinx and White engineering students' academic satisfaction and persistence intentions: Exploring interactions among social identities and institutional context

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ABSTRACT

Engineering has long lacked gender and racial diversity among its ranks, with Latinx and White women substantially underrepresented in engineering. The present study explored the role of social cognitive variables in engineering academic satisfaction and persistence intentions with a diverse sample of 1022 engineering students using the integrative social cognitive model of academic adjustment (Lent et al., 2013). Results indicated that (a) the hypothesized bidirectional model fit the data well for the full sample, subsamples based on race, gender, institution, race × gender, and race × institution, (b) all but six parameters were significant and in the expected direction for the full sample, (c) model parameters were invariant across race, gender, institution, and race × gender, but differed across race × institution subsamples, and (d) the relations within the model explained a significant amount of variance in engineering academic satisfaction and persistence intentions for the full sample and sub-samples. Implications of the findings are aimed at educational and career interventions focusing on retaining Latinx and women in engineering.

In spite of advances in diversifying science, technology, engineering and mathematics (STEM) fields in recent decades, engineering is among the least integrated STEM fields today. Data from the National Science Foundation (NSF, 2015) indicates that White (63.1%) and Asian (22.5%) individuals comprise the majority groups in the engineering workforce, followed by Latinx (8.7%), Black (3.8%), Native American (0.3%), and Native Hawaiian/Pacific Islander (0.2%) individuals. Women comprise only 14.5% of the engineering workforce (NSF, 2015). At the same time, Latinx and White women students have among the highest attrition rates in undergraduate engineering programs (National Center for Education Statistics, 2013). In 2014, White women, Latino, and Latina students earned only 11%, 7%, and 2% of undergraduate engineering degrees, respectively; in contrast, White men earned 50% of engineering degrees [National Science Foundation (NSF), 2017]. Given the underrepresentation of Latinx and women students and workers in engineering, the field—and society—misses out on the contributions that could be generated by talented, diverse professionals.

Engineering as a field is projected to grow over the next several years, increasing the demand for qualified engineers (Bureau of Labor Statistics, 2018). Today, Latinxs are the largest racial group in the U.S. after Whites (U.S. Census Bureau, 2018), contributing to

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the projected growth of Latinx workers in the labor force. In 2026, it is expected that *one in five workers will be Latinx* (Bureau of Labor Statistics, 2017). Further, women currently make up 47% of the labor force (Bureau of Labor Statistics, 2017). The field of engineering can benefit by tapping into these talented personnel pools as a means of broadening the diversity in the engineering workforce. One important approach to broaden the participation of underrepresented groups in engineering is to examine psychosocial factors contributing to their retention in undergraduate programs, as college is a necessary pathway for entry into the engineering workforce.

According to a recent report (Anderson et al., 2018), engineering graduates from underrepresented racial groups are concentrated at a few institutions. A significant percentage of Latinx students with engineering bachelor's degrees received them from a Hispanic Serving Institution (HSI), a university with 25% full-time undergraduate enrollment of Latinx students (Anderson et al., 2018). Given the important role of HSIs in training Latinx students in engineering, we add an important contextual element to our study—institution—to understand how engineering students' processes may vary based on the institution that they attend. The present study draws students from HSIs and predominantly White institutions (PWIs) to investigate the role of social cognitive variables (i.e., self-efficacy and outcome expectations) in the development of Latinx and White men and women undergraduate engineering students' academic satisfaction and intentions to persist in engineering over time. We build on the extant literature by examining variance by race, gender, institutional context, race × gender, and race × institution in these relations.

1. Theoretical framework

Lent et al.'s (2013) integrative social cognitive model of academic adjustment (herein referred to as the integrative SCCT model), derived from social cognitive career theory (SCCT; Lent et al., 1994, 2000) and the social cognitive model of academic satisfaction (Lent & Brown, 2006a), explains how people achieve satisfaction and persist in academic or career domains (see Fig. 1). The integrative SCCT model accounts for personal (i.e., personality and affective traits) and environmental (i.e., supports, resources and obstacles) factors that are hypothesized to influence social cognitions (i.e., self-efficacy and outcome expectations). In turn, these social cognitions are believed to inform the development of domain specific interests and satisfaction. All of these variables are theorized to be a direct or indirect source of persistence in a given academic or career domain. SCCT and its theoretical successors have been widely used to understand persistence in STEM fields (e.g., Byars-Winston et al., 2010; DuBow & James-Hawkins, 2016; Lent et al., 2018; Peña-Calvo et al., 2016), and to shed light on the underrepresentation of women and/or diverse racial groups in engineering (Cadaret et al., 2017; Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Flores et al., 2017; Fouad et al., 2016; Garriott et al., 2017; Lent et al., 2013, 2015, 2016; Navarro et al., 2014). For the current study, we focus on the integrative SCCT model variables of self-efficacy, outcome expectations, academic satisfaction, and persistence intentions.

A recent meta-analysis of 143 SCCT-based studies in STEM domains provided strong support for the integrative SCCT model and reported that SCCT variables accounted for 45% of the variance of STEM intended persistence (Lent et al., 2018). Relevant to the current study, this meta-analysis reported significant effects in the following paths: self-efficacy - outcome expectations (0.36); self-efficacy – STEM goal intentions (0.07); and outcome expectations – STEM goal intentions (0.28). Moreover, this meta-analysis reported a significant and practical racial difference in the path between outcome expectations and STEM goal intentions, with racial minority students endorsing a stronger effect than their majority peers. No significant and practical differences across gender groups were found among the relations between self-efficacy, outcome expectations, and STEM goal intentions.

SCCT-based research with engineering samples (Byars-Winston et al., 2010; Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Garriott et al., 2017; Inda et al., 2013; Lent et al., 2003, 2005, 2007, 2016, 2013, 2015, 2010, 2008; Navarro et al., 2014, 2019; Singh et al., 2013) has established that the data were a good fit to SCCT-based models, including the integrative SCCT model (Lent et al., 2013, 2015, 2016; Navarro et al., 2014, 2019), and explained robust variance in engineering

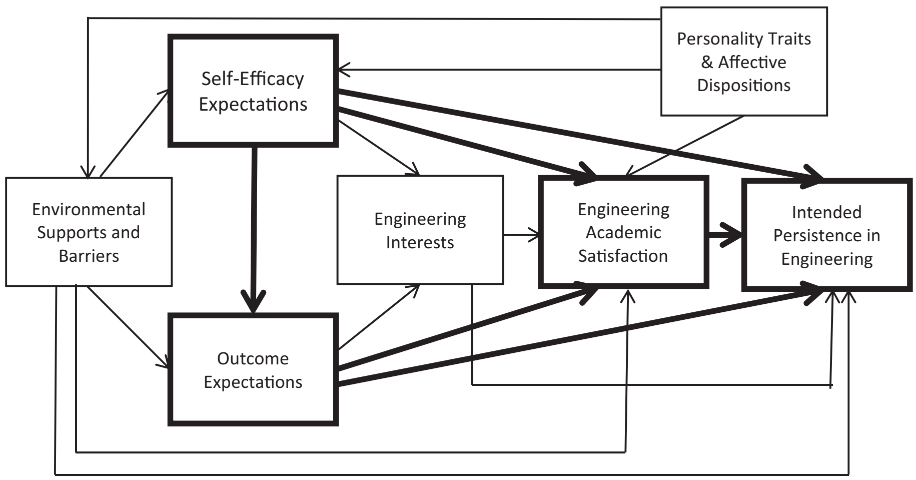

Fig. 1. The Integrative Social Cognitive Career Theory Model (Lent et al., 2013). Bolded boxes represent the variables tested in the current study, and bolded lines represent the hypothesized paths among the variables tested in the current study.

interests, satisfaction, and persistence intentions. Some of these studies examined relations within the SCCT-based models longitudinally, over semesters (Lent et al., 2008, 2010, 2016) or years (Navarro et al., 2014), and showed that the model relations held across time.

Stereotype threat theory (Steele & Aronson, 1995) posits that the psychological angst that arises when individuals are in situations or environments where they fear confirming negative stereotypes about their group membership (the threat), and the emotional energy expended on this threat interferes with their performance on a task. Stereotype threat has been used to account for gender and racial academic gaps, particularly in STEM fields. Findings from a meta-analysis indicated that the effects of stereotype threat were significant for both racial/ethnic minorities and women (Nguyen & Ryan, 2008). The strength of the threat differentially moderated the effects of stereotype threat among racial/ethnic minorities and women, with subtle threats producing the largest effect for women and the smallest effect for racial/ethnic minorities, and moderate threats producing the largest effect for racial/ethnic minorities and the smallest effect for women. Latinx and women are vulnerable to the activation of stereotype threat given their low representation in engineering, and these environmental conditions may undermine their decisions to persist in the field.

We explore model variance by race and gender to examine potential differences among SCCT paths that may explain the underrepresentation of Latinx and women students in engineering and point to areas to target for interventions to increase the representation of these groups. Whereas gender and racial group variance has been reported among SCCT paths in general STEM domains (Lent et al., 2018), paths in the SCCT model have been invariant across gender (Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Lent et al., 2013, 2015, 2016; Navarro et al., 2014) or race (Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Lent et al., 2013, 2015, 2016; Navarro et al., 2014) in the engineering domain.

We also examine institutional context as a moderator in the relations among the variables in the model. Prior scholars have conceptualized that the university environment and characteristics play a role in the students' academic outcomes (Hurtado et al., 1999). With the exception of Navarro et al. (2019), no study has compared the integrative SCCT model among students at HSIs with those at other types of universities. However, it is known that HSIs provide a unique context for Latinx students to study, given that they are more represented in these universities compared to PWIs (e.g., Cuellar, 2014). Latinx students attending PWIs report barriers in their academic training (Stebleton & Aleixo, 2015), experiences of racism on campus (Castellanos et al., 2018), and a lack of support for diversity on campus (Castellanos et al., 2018; Jones et al., 2002). Prior research reported that institutional characteristics, such as structural diversity or attending a minority-serving institution, were not significantly related to Latinx students' college graduation rates (Garcia, 2014) or persistence in STEM majors (Chang et al., 2014). However, other research suggests that the university environment and perceptions of the campus environment were linked to academic achievement (Cerezo & Chang, 2013) and persistence (Gloria et al., 2005) among Latinx students attending PWIs and points to other advantages of increased racial and gender representation in academic environments. For example, Cuellar (2014) found that Latinx attending HSIs reported gains in academic self-concept, whereas Latinx attending PWIs demonstrated a decrease in academic self-concept scores over their time in college. Further, prior research has demonstrated that increased representation of underrepresented students in engineering has been linked to higher levels of engineering self-efficacy (Lent et al., 2008; Marra et al., 2009) and intended persistence (Marra et al., 2009). These mixed findings suggest that institutional context may be an important variable worthy of further examination.

In recent years, there have been calls for psychological research to explore intersectionality given that people with different social identities hold various amounts of privilege and oppression (Cole, 2009). Recent qualitative investigations have highlighted the gendered racism encountered by women of color in STEM (Alexander & Hermann, 2016; Wilkins-Yel et al., 2019) and note the importance of extending research from understanding the general STEM experiences among intersectional groups to understanding how intersectionality effects STEM pathways. The current study explores race × institution and race × gender intersections. While we are exploring distinct social identities as proxies for the effects of privilege and oppression, exploring intersectionality differences is valuable to understanding if social identity and contextual factors interact to play a role in the pathways of persistence among underrepresented groups in undergraduate engineering programs.

We build on Navarro et al.'s (2019) cross-sectional study by testing the temporal relations of the SCCT model and examining the moderating effects of the intersections of race, gender, and institutional context. College enrollment among Latinx is increasing (National Center for Educational Statistics, 2010), and approximately half of all Latinx college students are enrolled at HSIs (NCES, 2010). Given the high number of Latinx students receiving degrees from HSIs (Anderson et al., 2018) and the different learning environments across HSIs and PWIs, we were interested in exploring whether Latinx students differed across institutions and if they differed from their racial counterparts within similar institutions. Navarro et al. reported that 11 SCCT model paths differed across race × institution groups. Relevant to the current study, the path from self-efficacy to academic satisfaction was stronger for both Latinx and White students at PWIs than Latinx students at HSIs, and the path from positive outcome expectations to academic satisfaction was significant for Latinx students at PWIs and nonsignificant for White students at HSIs. Related to race × gender differences, Navarro and colleagues reported that 6 paths differed across race × gender groups. Specifically, their study found that the path from positive outcome expectations to intended persistence was significant for Latino men and nonsignificant for White women, the path from self-efficacy to intended persistence was stronger for White men than White women, and the path from positive outcome expectations to academic satisfaction was stronger for White women than White men.

Our study contributes to the extant SCCT literature in several ways. First, we use a longitudinal design with two waves of data approximately a year apart given our focus on persistence outcomes and because student retention rates are traditionally tracked annually by institutions. Second, SCCT research is limited by studies that have largely focused on the role of positive expectancies on behaviors (Lee et al., 2018; Lent & Brown, 2006b); we extend SCCT research in the engineering domain by including measures of both positive and negative outcome expectations to be consistent with Bandura's (1986) definition of outcome expectations encompassing both positive and negative consequences. Our inclusion of separate measures to assess both positive and negative expectations may strengthen the explanatory power of SCCT in explaining persistence intentions for students from underrepresented groups. Indeed, Gibbons and Borders (2010) found that both positive and negative expectations had significant, unique effects on the college-going intentions among a racially diverse sample of potential first-generation college students.

In SCCT's original theoretical formulation, Lent et al. (1994) acknowledged the potential interactive effects among the variables in the model, and this was notably demonstrated in a longitudinal study by Nauta and colleagues (2002) in which they found support for the reciprocal nature of the self-efficacy and interests. The predominance of cross-sectional SCCT studies has limited exploration of reciprocal relations in the model. Thus, we further extend the SCCT literature by examining reciprocal paths between (a) self-efficacy and outcome expectations and (b) academic satisfaction and intended persistence, which are derived from prior studies with racially diverse engineering student samples (i.e., Hackett et al., 1992; Navarro et al., 2014). According to SCCT, individuals are likely to expect positive outcomes for activities in which they possess strong levels of efficacy. It seems reasonable, however, that anticipated outcomes for engaging in a behavior (either positive or negative) can motivate one to engage in activities that will influence self-efficacy beliefs. For example, if one anticipates negative outcomes for participating in engineering tasks, their motivation to participate in those tasks may decrease, reducing opportunities to experience success and to receive positive feedback for these activities, which may weaken self-efficacy beliefs. Further, although the integrated SCCT model hypothesizes that individuals are more likely to persist in academic disciplines in which they are satisfied, we expect that increased opportunities for success occur when one persists in a given field, which can reinforce feelings of satisfaction in the field. The studies (Hackett et al., 1992; Navarro et al., 2014) that inform these research questions and hypotheses were conducted with smaller engineering samples drawn from a single institution; the current study tests if these findings are replicated with larger representative sample. Finally, we add to previous SCCT studies by (a) drawing engineering students from multiple institutions representing both PWIs and HSIs, and (b) exploring the moderating effects among the relations in the model across three groups (race, gender, and institutional context) as well as race × gender and race × institution subgroups.

2. Present study

To summarize, this study tests a longitudinal integrative SCCT model (see Fig. 2) among a large, diverse sample of engineering students, examining some of the relations within Navarro et al.'s (2019) cross-sectional study. We extend Navarro et al.'s study by incorporating negative outcome expectations within the model, testing reciprocal effects among variables, and examining the temporal associations of the T1 variables in relation to T2 variables, controlling for the relations between the same variables across time. In accordance with theory, we hypothesize that: *(1) self-efficacy will have a positive effect on positive outcome expectation; (2) self-efficacy will have a negative effect on negative outcome expectations; (3) self-efficacy will have positive effects on academic satisfaction; (4) positive outcome expectations will have positive effects on academic satisfaction; (5) negative outcome expectations will have negative effects on academic satisfaction; (6) self-efficacy will have positive effects on intended persistence; (7) positive outcome expectations will have positive effects on intended persistence; (8) negative outcome expectations will have negative effects on intended persistence; and (9) academic satisfaction will have a positive effect on intended persistence.*

We examine the reciprocal effects of outcome expectations on self-efficacy and intended persistence on academic satisfaction; these reciprocal relations are exploratory. Our moderation analyses (race, gender, institution, race × gender, and race × institution) also are exploratory. We expect that some paths will be variant across subgroups based on previous research (Lent et al., 2018; Navarro et al.,

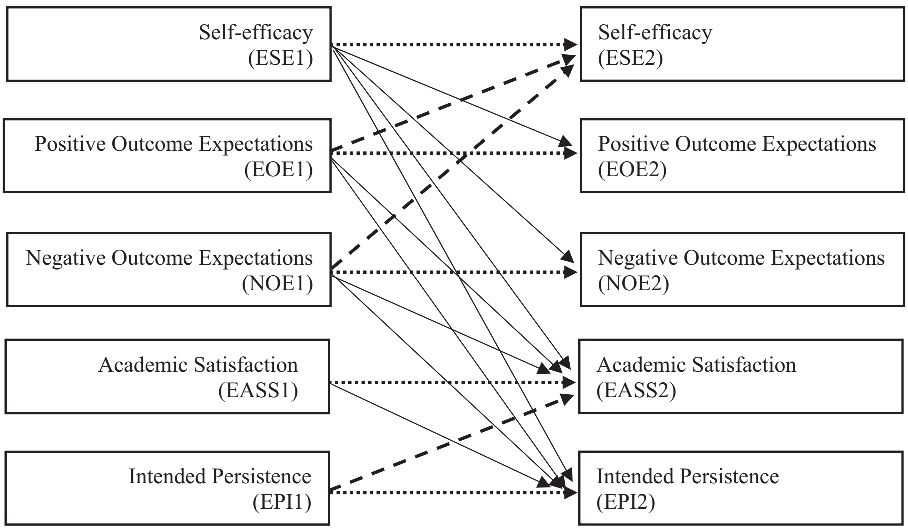

Fig. 2. Longitudinal model of intended persistence including reciprocal paths. Dotted lines represent autoregressive paths; solid lines represent cross-lagged paths hypothesized by Lent et al.'s (2013) integrative SCCT model; dashed lines represent reciprocal effects of three hypothesized cross-lagged paths. Covariances among variables at Time 1 and Time 2 are not depicted for ease of reading.

2019), but make no assumptions about the specific paths that will differ. Based on prior research, we expect that the model will be a good fit across subgroups and that SCCT variables will explain significant variance in persistence intentions across subgroups.

3. Method

3.1. Participants

Participants were 1022 engineering students attending HSIs (n = 399, 39%) and PWIs (n = 623, 61%) in the U.S. The sample consisted of 526 (51.5%) men, 493 (47.7%) woman, and 6 (0.3%) transgender individuals. Among the participants, 562 (55%) identified as Latinx, 441 (43.2%) identified as White, and 19 (1.9%) identified as multiracial/multiethnic (one group being Latinx or White). Of those attending HSIs, there were 321 Latinx and 78 White and of those attending PWIs, 230 were Latinx and 393 were White. At T1, participants included 260 (25.4%) first years, 280 (27.4%) sophomores, 352 (34.4%) juniors, 119 (11.7%) seniors, and 11 (1.1%) "other"; the mean age of the sample was 21.11 years (SD = 4.10 years, range = 18–57). The engineering majors represented were: 233 (22.8%) mechanical, 169 (16.5%) computer, 143 (16.5%) civil, 129 (12.6%) electrical, 113 (11.1%) bio-medical, 70 (6.8%) chemical, 51 (5.0%) industrial, 42 (4.1%) aerospace, 14 (1.4%) architectural, 9 (0.9%) engineering management, 7 (0.7%) manufacturing, 5 (0.5%) metallurgical and materials, 5 (0.5%) ocean, 4 (0.4%) geosystems engineering and hydrogeology, 2 (0.2%) materials science and engineering, and 26 (0.6%) did not report major.

3.2. Measures

Engineering Self-Efficacy (ESE; Lent et al., 2005). The ESE is a 4-item instrument that assesses confidence in one's ability to succeed in an engineering major (e.g., "excel in your engineering major over the next semester") using a 10-point Likert type scale ranging from 0 (*completely unsure*) to 9 (*completely sure*). Scores are averaged across all four items, with high scores reflecting high levels of engineering self-efficacy. Previous research has provided validity and reliability support of the scale's scores with Black, Latinx, and White engineering students (e.g., Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Lent et al., 2005, 2007). ESE scores were positively correlated with engineering outcome expectations, interests, goals, and academic satisfaction among an undergraduate sample of Latinx and White engineering students attending an HSI (Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014). Previous studies have reported coefficient alphas ranging from 0.91 to 0.92 for this measure among college student samples taking introductory engineering courses (Lent et al., 2005, 2007). The Cronbach's alpha for the current study was 0.90 at T1 and 0.92 at T2.

Positive Engineering Outcome Expectations (POE; Lent et al., 2003). The POE is a 10-item measure of a variety of positive outcomes that participants might expect from obtaining a college degree in engineering (e.g., "get respect from other people"). Items are answered using a 10-point Likert scale ranging from 0 (*strongly agree*) to 9 (*strongly agree*). Scores are averaged, with high scores reflecting high positive outcome expectations related to graduating in engineering. Scores have been positively correlated with engineering interests, social support, and goals (Lent et al., 2003, 2005, 2008). Previous studies have also reported coefficient alphas ranging from 0.89 to 0.91 for this measure (Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Lent et al., 2003, 2005). The Cronbach's alpha for the current study was 0.94 at T1 and 0.93 at T2.

Negative Outcome Expectations Scale-Engineering (NOES-E; Lee et al., 2018). The NOES-E is a 21-item measure of negative outcomes that one might expect from obtaining an engineering degree (e.g., "high levels of stress due to a demanding work environment that affects my home life"). Participants respond to items using a Likert scale ranging from 0 (*strongly disagree*) to 9 (*strongly agree*). The NOES-E is composed of four subscales: cultural-related stressors, personal life and work balance, job characteristics, and social costs. Construct validity of NOES-E scores was supported through a positive correlation with engineering barriers and negative correlations with engineering self-efficacy, academic satisfaction, intended persistence, supports, and positive outcome expectations (Lee et al., 2018). Previous research with Latinx and White engineering students reported a Cronbach's alpha of 0.94 for this measure (Lee et al., 2018); for the current study, it was 0.89 at T1 and 0.94 at T2.

Engineering Persistence Intentions (EPI; Lent et al., 2003). The EPI is a 4-item measure of academic persistence intentions in engineering (e.g., "I am fully committed to getting my college degree in engineering"). Participants respond to items using a 5-point Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly agree*). High scores indicate strong intentions to pursue an engineering degree. Prior research indicates that intended persistence is significantly and positively related to persistence decisions among engineering students (Lee et al., 2015; Lent et al., 2003, 2016), and so it has been used as a proxy in the absence of persistence behaviors. EPI scores were positively correlated with engineering self-efficacy, interests, positive outcome expectations, and actual verified persistence (Lent et al., 2003, 2013), and previous research with samples of engineering students have yielded internal consistency values ranging from 0.87 to 0.95 (Lent et al., 2003, 2005, 2008; Navarro et al., 2014). The Cronbach's alpha for the current study was 0.93 at T1 and 0.96 at T2.

Engineering Academic Satisfaction (EASS; Lent et al., 2007). The EASS is a 7-item measure of academic satisfaction in engineering (e.g. "I feel satisfied with the decision to major in engineering"). Participants respond to items using a Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Scores are averaged, with high scores indicating greater levels of satisfaction with an engineering major. EASS scores were correlated in expected directions with engineering self-efficacy, outcome expectations, goal progress, and supports (Lent et al., 2007). Previous research with samples of engineering students have found coefficient alphas ranging from 0.91 to 0.94 for this measure (Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Lent et al., 2007). The Cronbach's alpha for the current study was 0.93 at T1 and 0.93 at T2.

3.3. Procedures

Data for this study were collected at two time points (Spring 2015 and Spring 2016) approximately one year apart with engineering college students enrolled in 11 universities in the U.S. Because one of our main outcome variables is persistence in college, we chose to collect data one year apart as this is consistent with how retention rates are reported at the institutional level for national statistics (i.e., an undergraduate student who continues at school the next academic year). In Spring 2015 (T1), engineering students at these institutions were recruited to complete an online survey through classroom presentations, flyers, and email announcements. A year later in Spring 2016 (T2), all participants from T1 were invited via email to complete another survey. At T2, additional recruitment strategies were utilized (i.e., text messages, postcards, and phone calls) to target woman engineering students to maximize participation given their underrepresentation in engineering. We had a retention rate of about 64% from T1 to T2. Participants received a $20 gift card at T1 and a $40 gift card at T2.

4. Results

4.1. Preliminary data analyses

After excluding 42 participants who graduated at T2 and 518 participants who did not participate at T2, the data set consisted of 1022 participants. We examined the variables for skewness or kurtosis, and results suggested that intended persistence at T1 and T2 were extremely skewed (>|3.00|) and kurtotic (>|8.00|; Kline, 2005). The skewness and kurtosis values were acceptable for all of the other variables (i.e., skewness was <|2.00| and kurtosis was <|1.00|). To make the intended persistence values more appropriate for model testing, we used a rank transformation which resulted in more normally distributed values for intended persistence at both T1 and T2 (skewness and kurtosis values were <|1.00|) in the transformed T1 and T2 intended persistence variables. We then converted the values of all of the study's variables to z-scores for use in further model testing.

The percentage of missing data ranged from 12.93% to 66.53%. Following recommendations (Enders, 2010), we conducted Little's Missing Completely at Random (MCAR) test using SPSS to test if data were missing completely at random. The Little's MCAR test was significant ($p = .026$), suggesting that our data were not MCAR. We then created a dummy variable and utilized an independent sample *t*-test to examine the relationship between the dummy variable and the other variables in our data set. We found significant correlations between the dummy variable and variables in the study. Thus, the missingness pattern of our data was inferred to be missing at random (MAR; Schlomer et al., 2010; Garson, 2015). Accordingly, we conducted full information maximum likelihood (FIML) using Mplus for the main analyses. FIML is an advanced missing data method in which missing values are not replaced or imputed but are handled within the analysis model and has been demonstrated to deliver unbiased parameter estimates for MAR data (Arbuckle, 1996; Wothke, 2000; Schlomer et al., 2010).

Table 1
Means, standard deviations, reliability coefficients, and correlations among the study's variables at Time 1 and Time 2.

	1	2	3	4	5	6	7	8	9	10
1.ESE1	–									
2.EOE1	0.365**	–								
	$p = .002$									
3.NOE1	−0.247**	−0.271**	–							
	$p = .002$	$p = .003$								
4.EASS1	0.481**	0.412**	−0.279**	–						
	$p = .002$	$p = .002$	$p = .002$							
5.EPI1	0.325**	0.318**	−0.215**	0.341**	–					
	$p = .002$	$p = .002$	$p = .004$	$p = .002$						
6.ESE2	0.624**	0.254**	−0.242**	0.412**	0.291**	–				
	$p = .002$	$p = .002$	$p = .002$	$p = .003$	$p = .002$					
7.EOE2	0.289**	0.500**	−0.289**	0.394**	0.154**	0.373**	–			
	$p = .004$	$p = .002$	$p = .002$	$p = .002$	$p = .002$	$p = .002$				
8.NOE2	−0.244**	−0.190**	0.415**	−0.266**	−0.154**	−0.306**	−0.289**	–		
	$p = .002$	$p = .003$	$p = .002$	$p = .002$	$p = .003$	$p = .003$	$p = .003$			
9.EASS2	0.377**	0.312**	−0.235**	0.559**	0.268**	0.557**	0.493**	−0.358**	–	
	$p = .003$	$p = .002$	$p = .002$	$p = .004$	$p = .005$	$p = .002$	$p = .002$	$p = .002$		
10.EPI2	0.243**	0.165**	−0.113**	0.273**	0.402**	0.446**	0.230**	−0.191**	0.465**	–
	$p = .003$	$p = .002$	$p = .002$	$p = .002$	$p = .005$	$p = .004$	$p = .002$	$p = .002$	$p = .002$	
M	7.00	7.42	3.66	4.15	4.66	6.87	7.36	3.23	4.10	4.61
SD	1.98	1.66	2.39	0.90	0.75	2.14	1.64	2.37	0.96	0.89
α	0.90	0.94	0.89	0.93	0.93	0.92	0.93	0.94	0.93	0.96

Note. *$p < .05$; **$p < .01$; ns = non-significant; ESE = Engineering self-efficacy, EOE = Engineering positive outcome expectations, NOE = Engineering negative outcome expectations, EASS = Engineering academic satisfaction, EPI = Engineering intended persistence.

4.2. Primary analyses: full sample model comparisons

Table 1 shows the means, standard deviations, reliability coefficients, and correlations among the study's variables at T1 and T2 for the full sample. To test the integrative SCCT model longitudinally, we compared three model variations. First, to demonstrate variable stability over time, we tested a base model containing (a) covariances among T1 variables, (b) covariances among T2 variable error variances, and (c) autoregressive paths (i.e., direct paths between the same variables across T1 and T2). We then tested a unidirectional model, which included the base model along with the hypothesized cross lagged paths. Next, we tested a bidirectional model, which included the base and unidirectional models along with reciprocal paths.

Each model was tested using path analytic techniques via Mplus 7.4 using maximum likelihood estimation with robust standard errors (MLR) and FIML. To determine model fit, we examined the Satorra–Bentler scaled chi-square (SBSχ^2), comparative fit index (CFI), the standardized root mean square residual (SRMR), and the root-mean-square error of approximation (RMSEA). Because SBSχ^2 is sensitive to sample size and a significant SBSχ^2 may not be indicative of poor fit, Kline (2005) suggested that adequate fit is denoted when CFI $\geq$ 0.90, SRMR $\leq$ 0.10 and RMSEA $\leq$ 0.08, whereas an excellent fit is found when CFI $\geq$ 0.95, SRMR $\leq$ 0.08, and RMSEA $\leq$ 0.06. After determining model fit, we compared models to determine which model fit the data better using the Satorra–Bentler chi-square tests of difference (SBS$\Delta\chi^2$; Satorra & Bentler, 2001). Significant SBS$\Delta\chi^2$ values suggest improvement of fit to the data for one model over the other. See Table 2 for model fit indices and SBS$\Delta\chi^2$ findings.

The *base model* fit the data well (CFI = 0.92, SRMR = 0.09, RMSEA = 0.06), with SBSχ^2(19) = 122.17, $p < .001$. All of the covariances among T1 variables and covariances among T2 variable error variances were significant. All of the autoregressive paths between T1 and T2 variables also were significant ($p < .001$) with moderate to large path coefficients for most variables suggesting moderate to high stability among the variables over a 1-year period. The *unidirectional model* was an excellent fit to the data (CFI = 0.97, SRMR = 0.04, RMSEA = 0.05), with SBSχ^2(11) = 53.70, $p < .001$. The results of the base model were consistent in this model, and the following cross-lagged paths were significant: (a) T1 self-efficacy to T2 positive outcome expectations, T2 negative outcome expectations, T2 intended persistence, and T2 academic satisfaction, and (b) T1 positive outcome expectations to T2 intended persistence and T2 academic satisfaction. The unidirectional model was an improved fit over the base model [SBS$\chi^2\Delta$(8) = 69.07, $p < .001$] (Table 3). The *bidirectional model* also was an excellent fit to the data (CFI = 0.97, SRMR = 0.03, RMSEA = 0.05), with SBSχ^2(8) = 45.09, $p = .01$, and demonstrated an improvement over the base model [SBS$\Delta\chi^2$ (11) = 77.10, $p < .001$] and the unidirectional model [SBS$\chi^2\Delta$(3) = 8.86, $p = .031$]. Furthermore, the results of the base and unidirectional models were mostly retained in the bidirectional model, except that the path from T1 positive outcome expectations to T2 academic satisfaction was significant in the unidirectional model ($\beta = 0.008$) but nonsignificant in the bidirectional model ($\beta = 0.003$). Although statistically significant due to the large sample size, the practical significance of this path in the unidirectional model was very small. We retained the bidirectional model as the one significant reciprocal path from T1 negative outcome expectations to T2 self-efficacy added unique variance to self-efficacy and explains an alternative pathway in which negative outcome expectations may influence academic outcomes in engineering. The bidirectional model provided support for Hypotheses 1, 2, 3, 6, and 7, and one of the 3 reciprocal paths that were tested (relation between self-efficacy and negative outcome expectations). Hypotheses 4, 5, 8 and 9 were not supported (Table 3). The paths within the bidirectional model explained 40.8%, 27.0%, 20.2%, 18.5%, and 29.5% of the variances in T2 self-efficacy, positive outcome expectations, negative outcome expectations, academic satisfaction, and intended persistence, respectively. See Table 4 for path coefficients in the unidirectional and bidirectional models.

4.3. Multiple group analyses of the bidirectional model

4.3.1. Single group moderators

We determined if the data fit the bidirectional model well for men, women, Latina students, Latino students, HSI students, and PWI students separately by conducting a series of multiple group analyses using MLR and FIML estimation methods via Mplus 7.4 to

Table 2
Summary of fit statistics for the base, unidirectional and bidirectional models and the chi-square difference tests for the full sample.

Model	SBSχ^2	*df*	CFI	SRMR	RMSEA	95%CI	ΔSBSχ^2	Δdf
1. Base	122.17*** $p < .001$	19	0.92	0.09	0.06	0.05,0.07		
2. Unidirectional	53.70*** $p < .001$	11	0.97	0.04	0.05	0.04,0.06		
3. Bidirectional	45.09* $p = .011$	8	0.97	0.03	0.05	0.04,0.07		
Base vs. Unidirectional							69.07*** $p < .001$	8
Base vs. Bidirectional							77.10*** $p < .001$	11
Unidirectional vs. Bidirectional							8.86* $p = .031$	3

Note. *$p < .05$; **$p < .01$; **$p < .001$; ns = non-significant; SBSχ^2 = Satorra–Bentler scaled chi-square; *df* = degrees of freedom; CFI = comparative fit index; SRMR = standardized root mean residual; RMSEA = root mean-square error of approximation; CI = confidence interval; SBS$\Delta\chi^2$ = Satorra–Bentler chi-square difference; Δdf = df difference.

Table 3
Summary of standardized path coefficients for the full sample.

Time 2 Dependent variables	Time 1 Predictor variables	Path coefficients from T1 predictors to T2 dependent variable	
		Unidirectional model	Bidirectional model
ESE2	ESE1	0.634*** $p < .001$	0.607*** $p < .001$
	EOE1		0.025^{ns}
	NOE1		−0.072* $p = .025$
EOE2	EOE1	0.448*** $p < .001$	0.456*** $p < .001$
	ESE1	0.136*** $p < .001$	0.132*** $p < .001$
NOE2	NOE1	0.380*** $p < .001$	0.390*** $p < .001$
	ESE1	−0.149*** $p < .001$	−0.143*** $p < .001$
EASS2	EASS1	0.355*** $p < .001$	0.344*** $p < .001$
	ESE1	0.155*** $p < .001$	0.125** $p = .002$
	EOE1	0.008** $p = .002$	0.003^{ns}
	NOE1	0.043^{ns}	0.020^{ns}
	EPI1		0.061^{ns}
EPI2	EPI1	0.341*** $p < .001$	0.353*** $p < .001$
	ESE1	0.177*** $p < .001$	0.161*** $p < .001$
	EOE1	0.085* $p = .013$	0.093* $p = .011$
	NOE1	-0.029^{ns}	-0.055^{ns}
	EASS1	0.049^{ns}	0.045^{ns}

Note. *$p < .05$; **$p < .01$; **$p < .001$; ns = non-significant; ESE = Engineering self-efficacy, EOE = Engineering positive outcome expectations, NOE = Engineering negative outcome expectations, EPI = Engineering intended persistence, EASS = Engineering academic satisfaction. Reciprocal paths within the bidirectional model are shown in bold font.

Table 4
Summary of fit statistics for intersectional groups.

Model	χ^2	*df*	CFI	SRMR	RMSEA	95% CI
Race × gender groups						
Latina	19.417* $p = .013$	8	0.963	0.050	0.087	0.038,0.137
Latino	16.267* $p = .039$	8	0.978	0.0036	0.006	0.013,0.102
White women	12.394^{ns}	8	0.988	0.032	0.050	0.000,0.102
White men	12.576^{ns}	8	0.985	0.040	0.057	0.000,0.115
Race × institution groups						
Latinx at HSIs	18.278* $p = .019$	8	0.972	0.041	0.068	0.026,0.110
Latinx at PWIs	8.680^{ns}	8	0.998	037	0.002	0.000,0.087
Whites at HSIs	7.628^{ns}	8	1.00	0.039	0.000	0.000,0.144
Whites at PWIs	12.815^{ns}	8	0.992	0.032	0.043	0.000,0.084

Note. *$p < .05$; **$p < .01$; **$p < .001$; ns = non-significant; χ^2 = chi-square; *df* = degrees of freedom; χ^2/df = ratio of chi-square to degree of freedom; CFI = Comparative Fit Index; SRMR = standardized root mean residual; RMSEA = root mean square error of approximation; CI = confidence intervals.

determine model invariance by gender, race, or institution. The bidirectional model was fit using separate covariance matrices for each group and tested using increasingly restrictive parameter sets [i.e., no path constraints (unconstrained) to full constraints across the specific groups (constrained)]. We examined CFI, SRMR, and RMSEA along with the SBSχ^2 to determine if the single group models fit the data. The SBS$\Delta\chi^2$ was used to compare the unconstrained and fully constrained models to assess group invariance. When group variance was detected, we constrained one path at a time and compared the fully unconstrained model to the model with one constrained path to determine the specific paths that were significantly different across groups. While the SBS$\Delta\chi^2$ provides information about statistically significant differences, it is sensitive to both sample size and subsample size differences. Also, given the number of group comparisons, the potential for error increased. Thus, we use Lent et al.'s (2018) approach for attending to practically significant differences, or path differences ≥0.10.

4.3.2. Race as a moderator

The unconstrained [SBSχ^2(16) = 48.23, $p < .001$; CFI = 0.98; SRMR = 0.04; RMSEA = 0.05] and constrained [SBSχ^2(33) = 69.59, $p < .001$; CFI = 0.97; SRMR = 0.04; RMSEA = 0.004] models were both an excellent fit to the data. The bidirectional model was invariant across racial groups [SBS$\chi^2\Delta$(17) = 23.25, $p > .05$].

4.3.3. Gender as a moderator

The unconstrained [SBSχ^2(16) = 54.72, $p < .001$; CFI = 0.97; SRMR = 0.04; RMSEA = 0.06] and constrained model [SBSχ^2(33) = 78.48, $p < .001$; CFI = 0.97; SRMR = 0.05; RMSEA = 0.04] both had excellent model-to-data fit. Gender did not moderate the relations within the model [SBS$\chi^2\Delta$(17) = 25.49, $p > .05$].

4.3.4. Institution as a moderator

The unconstrained [SBSχ^2(16) = 46.12, $p < .001$; CFI = 0.98; SRMR = 0.04; RMSEA = 0.05] and constrained [SBSχ^2(33) = 67.61, $p < .001$; CFI = 0.98; SRMR = 0.05; RMSEA = 0.04] models were both an excellent fit to the data. The bidirectional model was invariant across institutional groups [SBS$\chi^2\Delta$(17) = 22.58, $p > .05$].

4.3.5. Intersectional group moderators

We explored model invariance across race × gender and race × institution groups. We followed the same procedures outlined above to examine model fit for each subgroup and to explore model invariance among subgroups.

4.3.5.1. Race × gender moderator. We compared the model across 4 groups determined by race × gender (Latino men, Latina women, White men, White women). Separate path analyses found adequate to close model fit for each of the four groups based on the CFI and SRMR. RMSEA values were excellent except for Latina women (see Table 4). Using multiple group path analyses, we tested and compared the unconstrained and constrained models across the 4 groups simultaneously; and the SBSχ^2 test of difference suggested no differences among the relations within the hypothesized model (see Table 5).

4.3.5.2. Race × institution moderator. We compared the model fit across 4 groups determined by race × institution (i.e., Latinx students at HSIs, White students at HSIs, Latinx students at PWIs, White students at PWIs). We found an adequate to close model-to-data fit for each group based on the CFI, SRMR, and RMSEA values (see Table 4). The SBSχ^2 test was significant, suggesting model variance across the 4 groups (see Table 5). To determine the location of the differences, we compared the 4 groups individually to one another, resulting in 6 separate multiple group analyses using the procedures described earlier. The SBS$\Delta\chi^2$ demonstrated model variance between (a) Latinx students at HSIs and PWIs, and (b) Latinx students and White students at PWIs (see Table 6).

Three paths in the model differed between Latinx students at HSIs and PWIs. The autoregressive path from positive outcome expectations was stronger for Latinx students at HSIs ($\beta = 0.49$, $p < .001$) than at PWIs ($\beta = 0.30$, $p = .003$), while the path from T1 academic satisfaction to T2 academic satisfaction was stronger for Latinx students at PWIs ($\beta = 0.43$, $p < .001$) than at HSIs ($\beta = 0.30$, $p < .001$). The path from T1 positive outcome expectations to T2 academic satisfaction was significant for Latinx students in PWIs ($\beta = 0.19$, $p = .03$) but not significant for Latinx students at HSIs ($\beta = -0.06$, $p > .05$).

Four paths differed between Latinx students and White students at PWIs. The autoregressive path from positive outcome expectations was stronger for White students ($\beta = 0.49$, $p < .001$) than Latinx students ($\beta = 0.13$, $p = .003$) at PWIs, whereas the academic satisfaction autoregressive path was stronger for Latinx students ($\beta = 0.46$, $p < .001$) than White students ($\beta = 0.24$, $p < .001$) at PWIs. The path from T1 positive outcome expectations to T2 academic satisfaction was significant for Latinx students at PWIs ($\beta = 0.26$, $p = .002$) but nonsignificant for White students at PWIs ($\beta = -0.01$, $p > .05$), while the path from T1 negative outcome expectations to T2

Table 5
Summary of fit statistics for Multiple Group Omnibus Test.

Model	χ^2	*df*	CFI	SRMR	RMSEA	95% CI	SBS$\Delta\chi^2$	Δdf
Race × Gender Multiple Group Omnibus Test								
Unconstrained	61.045** $p = .002$	32	0.979	0.039	0.065	0.039,0.089		
Constrained	110.943* $p = .022$	83	0.979	0.060	0.039	0.016,0.057		
Unconstrained vs. Constrained							51.727^{ns}	51
Race × Institution Multiple Group Omnibus Test								
Unconstrained	47.295* $p = .040$	32	0.989	0.037	0.047	0.010,0.074		
Constrained	124.767** $p = .002$	83	0.970	0.066	0.048	0.029,0.065		
Unconstrained vs. Constrained							77.450** $p = .010$	51

Note. *$p < .05$; **$p < .01$; **$p < .001$; ns = non-significant.

Table 6
Summary of fit statistics for Race × Institution Multiple Group Analyses.

Model	χ^2	*df*	CFI	SRMR	RMSEA	95% CI	SBS$\Delta\chi^2$	Δdf
Latinx at HSI vs. Latinx at PWI								
Unconstrained	26.156^{ns}	16	0.986	0.039	0.052	0.000, 0.086		
Constrained	66.790***	33	0.953	0.65	0.066	0.043, 0.088		
	$p < .001$							
Unconstrained vs. Constrained							41.45***	17
							$p < .001$	
Latinx at HSI vs. Whites at PWI								
Unconstrained	31.093*	16	0.984	0.036	0.056	0.025, 0.085		
	$p = .013$							
Fully Constrained	58.072**	33	0.974	0.048	0.050	0.028, 0.071		
	$p = .005$							
Unconstrained vs. Constrained							27.10^{ns}	17
Latinx at HSI vs. Whites at HSI								
Unconstrained	26.535*	16	0.978	0.041	0.062	0.007, 0.103		
	$p = .047$							
Fully constrained	41.929^{ns}	33	0.981	0.062	0.040	0.000, 0.073		
Unconstrained vs. Constrained							16.53^{ns}	17
Latinx at PWI vs. Whites at PWI								
Unconstrained	21.149^{ns}	16	0.994	0.034	0.035	0.000, 0.071		
Fully constrained	56.649**	33	0.974	0.060	0.052	0.028, 0.074		
	$p = .006$							
Unconstrained vs. Constrained							36.54**	17
							$p = .004$	
Latinx at PWI vs. Whites at HSI								
Unconstrained	16.458^{ns}	16	0.999	0.038	0.015	0.000, 0.083		
Fully Constrained	26.071^{ns}	33	1.000	0.054	0.000	0.000, 0.043		
Unconstrained vs. Constrained							10.14^{ns}	17
Whites at PWI vs. Whites at HSI								
Unconstrained	20.749^{ns}	16	0.993	0.033	0.039	0.000, 0.081		
Fully Constrained	39.172^{ns}	33	0.991	0.061	0.031	0.000, 0.063		
Unconstrained vs. Constrained							18.59^{ns}	17

Note. *$p < .05$; **$p < .01$; **$p < .001$; ns = non-significant; χ^2 = chi-square; *df* = degrees of freedom; χ^2/df = ratio of chi-square to degree of freedom; CFI = Comparative Fit Index; SRMR = standardized root mean residual; RMSEA = root mean square error of approximation; CI = confidence intervals.

academic satisfaction was significant for White students at PWIs ($\beta = 0.12$, $p = .024$) but nonsignificant for Latinx students at PWIs ($\beta = -0.05$, $p > .05$).

5. Discussion

The present study applied Lent et al.'s (2013) integrative SCCT model of academic adjustment with a large, diverse sample of engineering undergraduates from multiple U.S. institutions, examining the relations among the model's variables over approximately 12 months. The large sample allowed us to explore the moderating effects among the relations in the model across groups based on social identities and context (i.e., race, gender, and institution) both individually as well as the interactions among race × gender and race × institution. Additionally, measuring both positive and negative outcome expectations expands how this construct has been operationalized in prior research, which has reported inconsistent findings in terms of the significance of positive outcome expectations in the SCCT model. The current findings generally documented the utility of social cognitive mechanisms in explaining academic satisfaction and persistence intentions in engineering undergraduates across Latinx and Whites, women and men, and students at HSIs and PWIs, but highlighted some paths within the model that differed across some groups based on the interaction of their racial background and institutional context. Specifically, findings indicated that (a) a bidirectional model fit the data for the full sample better than the unidirectional and base models; (b) the path coefficients between the same variables across time were moderate to large and positive, indicating that levels of engineering-related self-efficacy, positive outcome expectations, negative outcome expectations, academic satisfaction and intended persistence were moderately to highly stable over a 1-year period (c) 5 of the 9 hypothesized cross-lagged relations were significant for the full sample (supporting hypotheses 1, 2, 3, 6, and 7), except the paths from engineering positive (hypothesis 4) and negative outcome expectations (hypothesis 5) to engineering academic satisfaction, from engineering negative outcome expectations to engineering intended persistence (hypothesis 8), and from engineering academic satisfaction to engineering intended persistence (hypothesis 9); (d) the model parameters did not vary across race (Latinx vs. White), gender (men vs. women), institution (HSI vs. PWI), or race × gender (comparisons between Latino men, Latina women, White men, White women); and (e) six model parameters differed for race × institution (specifically, between Latinx students at PWIs compared to Latinx students at HSIs and White students at PWIs). Important findings from this study are presented in the following paragraphs, by highlighting those model relations that were the same for the full sample and then addressing the model relations that differed across Latinx students at PWIs and their Latinx peers at HSIs and White peers at PWIs.

5.1. Integrative SCCT model relations for the full sample

5.1.1. Relationships among focal tenets in the model

The current study was a longitudinal examination of some of the relations within Navarro et al.'s (2019) cross-sectional study, and the relations in the current study held up across time. Most relations, or 4 of 6 paths, among self-efficacy, positive outcome expectations, academic satisfaction, and intended persistence were supported by the data. That is, greater intentions to persist in engineering at T2 were associated with greater confidence in completing engineering-related tasks and stronger beliefs about the positive outcomes of pursuing an engineering degree at T1. Varied relationships have been reported among these variables in prior longitudinal studies (Lent et al., 2015, 2016; Navarro et al., 2014). Specifically, the significant influences of both self-efficacy and positive outcome expectations on intended persistence among engineering students was found across two studies (Lent et al., 2015, 2016), but neither self-efficacy nor positive outcome expectations predicted intended persistence among a sample of diverse engineering students attending a single HSI (Navarro et al., 2014).

In terms of engineering academic satisfaction, prior studies reported that both self-efficacy and positive outcome expectations were significant predictors for academic satisfaction (Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Lent et al., 2013), but self-efficacy was the only significant predictor in other studies (Lent et al., 2015, 2016; Navarro et al., 2014). Our findings were consistent with the latter group of studies, in that self-efficacy but not positive outcome expectations were related to academic satisfaction for our full sample. Given the institutional differences and the time frame between data collections across studies, this inconsistent finding may suggest the examination of other cultural and contextual factors for racially diverse engineering students as sources of intended persistence in their degree. Furthermore, the relation between academic satisfaction and persistence intentions was non-significant for our sample. This is inconsistent with previous studies (Lent et al., 2013, 2015, 2016; Navarro et al., 2014) that showed positive impacts of academic satisfaction on persistence intentions among engineering students or vice versa. This, again, may indicate the importance of other cultural and contextual considerations for understanding engineering students' academic persistence.

5.1.2. Test of reciprocal relationships

The only reciprocal relationship that was supported with our full sample was between engineering self-efficacy and negative outcome expectations in engineering. That is, students' beliefs in their ability to accomplish tasks in engineering contributed to a reduction in negative outcome expectations and in turn fewer negative outcome expectations for pursuing an engineering degree enhanced engineering self-efficacy beliefs across time. The effect of outcome expectations on self-efficacy is consistent with other studies with samples of engineering students (Hackett et al., 1992; Lent et al., 2010), and suggest that negative outcome expectations may influence academic satisfaction and intended persistence indirectly via its effects on engineering self-efficacy. Given that positive outcome expectations have not consistently demonstrated a significant temporal relationship with academic satisfaction and persistence in previous longitudinal research among engineering students (i.e., Lent et al., 2015, 2016; Navarro et al., 2014), the reciprocal, causal relationship between negative outcome expectations and engineering self-efficacy is notable as it suggests that when outcome expectations are negative in nature versus positive, they may feed into students' self-efficacy in a harmful way. Thus, it seems imperative to intervene to counteract *negative* anticipated outcomes in engineering as a means of promoting satisfaction and persistence among engineering students. As one of the few studies (Bonifacio et al., 2018; Gibbons & Borders, 2010; Hackett et al., 1992) to incorporate measures of both positive and negative outcome expectations within a SCCT model, future research is needed to discern the effects of both types of outcome expectations on engineering students' academic outcomes. Also, the indirect relation among negative outcome expectations, self-efficacy, and intended persistence should be explored in future studies to gain further clarification of the relation of negative outcome expectations to intended persistence across time.

5.2. Investigation of multiple group differences

The model was a good fit for groups based on race, gender, and institution, and consistent with previous studies, model parameters did not differ across these groups (e.g., Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Lent et al., 2013, 2015, 2016; Navarro et al., 2014). However, group comparisons along single dimensions may mask multi-dimensional differences, as we found institutional variations between Latinx students and racial differences between students attending PWIs.

The integrative SCCT model was invariant across race × gender groups, indicating that the relations among the variables were generally similar for men and women across racial groups. Navarro et al. (2019) also reported that, using cross-sectional data, an extended version of the integrative SCCT model also was invariant across Latinos and Latinas, Latinos and White men, and Latinas and White women. In contrast, we found that seven paths varied between race × institution groups. Navarro et al. (2019) also reported race × institution intersectional differences in their cross-sectional study, but there was not an overlap in the paths that differed between that study and the current study, suggesting differences between cross-sectional and temporal relations among groups. Below, we discuss those differences that were significant and practical.

Four autoregressive paths emerged as different in the race × institution group comparisons. Specifically, our findings indicated that positive outcome expectations are less stable over time and academic satisfaction are more stable over time for Latinx at PWIs in comparison to both Latinx at HSIs and Whites at PWIs. This suggests that positive expectancies in engineering are sustained and reinforced at stronger rates within university environments with a significant mass of students from similar racial backgrounds and when racially-similar faculty are represented. Prior research suggests that simply being in an academic environment where Latinx faculty and peers are represented serves as a powerful, natural reinforcer for Latinx students (Cole, 2007; Hagedorn et al., 2007; Hurtado, 1992; Hurtado et al., 1996), and this appears to be the case for Latinx engineering students attending HSIs in our study. Engineering programs housed within PWIs may want to create more educational experiences that capitalize on positive expectations related to engineering careers for their Latinx students. We also found that academic satisfaction for Latinx students is more stable when they are studying in an environment where they are underrepresented; perhaps thriving within a potentially challenging academic environment boosts their satisfaction within their major. Alternatively, this finding may also reflect differences in students who enroll at a PWI versus an HSI, as students who attend HSIs start college with lower academic self-concepts (Cuellar, 2014) and have lower math achievement scores (Nuñez & Bowers, 2012) than their peers who attend non-HSIs. The gap in academic-related cognitions may decrease as students progress through college, with one study reporting no significant differences in college satisfaction between Latinx college seniors at PWIs and HSIs (Nelson Laird et al., 2007).

Three cross-lagged paths were variant across race × institution groups. First, our findings indicated that positive outcome expectations are beneficial in enhancing the academic satisfaction in engineering among Latinx students in predominantly White environments, but not for their racial peers at HSIs or for their racial counterparts at PWIs. The environment at PWIs represents challenges for Latinx students given their numerical minority status including, but not limited to, daily experiences of racism (Castellanos et al., 2018) and exposure to situations that regularly activate stereotype threat (Nguyen & Ryan, 2008). Such challenges may make positive perceptions about the benefits of pursuing and earning an engineering degree more important in the process of sustaining Latinx students' academic satisfaction at PWIs than for their White peers at PWIs who do not necessarily face such challenges. While Latinx students at HSIs may still experience discrimination and stereotype threat, these challenges may not be as prominent or happen as regularly in an environment where they are more well represented, making positive outcome expectations not as key in sustaining their academic satisfaction as it is for Latinx students at PWIs. Future research is needed to examine factors that are influencing the relations among positive outcome expectations and academic satisfaction across race × institution. Interestingly, negative outcome expectations were positively associated with academic satisfaction a year later for White students at PWIs and nonsignificant for Latinx students at PWIs. However, the bivariate correlation showed a negative relation between the two variables, indicating a likely suppression effect given the number of variables we tested. Although prior studies did not find significant relations between positive outcome expectations and academic satisfaction longitudinally (Lent et al., 2015, 2016; Navarro et al., 2014), our finding suggest that *positive* outcome expectations play an important role in the academic satisfaction of Latinx engineering students at PWIs where they are a numerical minority, and point to the importance of developing interventions that focus on strengthening and reinforcing positive outcome expectations for Latinx students at PWIs. Taken together, these findings point to the differential impact of positive outcome expectations on engineering academic satisfaction based on the intersection of individual inputs (i.e., race) and environmental context (i.e., institution).

To summarize, our findings indicated that the associations among the SCCT variables were generally similar across groups based on race, gender, institution, and race × gender. However, differences emerged in seven paths when we compared the model across race × institution groups. While our findings provide strong support for the generalizability of the model across groups, they highlight specific areas that may be targeted in counseling and classroom interventions to improve the academic satisfaction and persistence intentions of Latinx students depending on whether they attend an HSI or a PWI.

5.3. *Limitations and future research*

These findings should be interpreted in the context of some limitations. First, while the large sample is an obvious strength of the study, it was a convenience sample of Latinx and White engineering undergraduates, which introduces selection bias and constrains the representativeness of our sample. We grouped all Latinx engineering students into one subsample, although there are Latinx ethnic subgroup differences that can influence academic pursuits. Future studies can use a more purposive sampling method.

Second, measurement limitations included the use of single self-report measures of each construct and unidimensional measures that may not fully capture the complex nature of each construct (e.g., engineering self-efficacy). Thus, employing multiple sources to assess constructs can help to reduce measurement biases. Third, we used only one environmental factor in the present study, which was institution type. Other institutional factors should be considered, such as size, location of the school, the ratio of gender and racially diverse faculty members as well as students in engineering, campus climate, and climate within the college and department. Fourth, as this study addresses the relations among the variables across two time points, future research should extend longitudinal waves beyond two time periods and examine patterns of change among the variables over time. Finally, our study tested this model in the engineering domain. Future research can examine the model with students in other STEM domains to understand if these findings are similar across STEM fields and can inform strategies for broadening participation in other fields.

5.4. *Implications for practice*

The present findings provide several implications for practice. Given the temporal nature of the study, the findings confirm the role of engineering self-efficacy on academic satisfaction and intended persistence. Similar to prior studies (Flores, Navarro, Lee, Addae, et al., 2014; Flores, Navarro, Lee, & Luna, 2014; Lent et al., 2013, 2015, 2016), self-efficacy beliefs in engineering-related tasks impact engineering students significantly, affecting positive/negative outcome expectations, academic satisfaction, and persistence intentions in engineering. Thus, emphasis on Bandura's (1986) four sources of self-efficacy (e.g., performance accomplishments, social persuasion, vicarious learning, and managing emotional arousal) in interventions should be promoted. Furthermore, based on our finding that negative outcome expectations are a negative precursor to self-efficacy in engineering and vice versa, school administrators and academic professors should consider addressing both general and racial/gender-specific challenges of being an engineer while simultaneously providing advice for addressing these challenges. Engineering faculty and administrators can also work together with engineers in the field to address ways to ameliorate the negative outcomes that students link to engineering pursuits. In addition, our findings inform how interventions can be tailored based on students' institutional context. Particularly, Latinx engineering students attending PWIs may benefit from focusing on positive outcome expectations as a way to promote their academic satisfaction, while White students at PWIs may enhance their academic satisfaction through addressing negative outcome expectations. That is, designing coursework considering the balance between challenge and support would benefit both Latinx and White students.

It also may be essential to consider HSI students' progress in pursuing an engineering degree, as their level of academic satisfaction can be the key to promoting later intended persistence. Psychologists may explore the ways to enhance their satisfaction through hands-on or/and psycho-educational interventions and improving students' understanding of what they and their families may be able to gain from earing an engineering degree as a way of promoting their academic satisfaction and persistence in the field. Mentoring programs among advanced and first- or second-year students can be a good approach, as junior students can learn by observing advanced students.

Overall, the results of the current study provide partial support for Lent et al.'s (2013) integrative SCCT model for a sample of Latinx and White engineering students from PWIs and HSIs. A key implication of our study is the need for further study of how intersectional group affiliations inform the experiences and outcomes of engineering students, and the importance of designing and conducting interventions that are tailored for groups based on intersectional considerations, especially for Latinx at PWIs. Finally, the role of negative outcome expectations as a target for interventions is important given its reciprocal relation with self-efficacy beliefs, a core mechanism by which engineering students develop academic satisfaction and persistence intentions in engineering.

CRediT authorship contribution statement

Lisa Y. Flores: Conceptualization, Methodology, Writing – original draft, Writing - review & editing, Supervision, Project administration, Funding acquisition. **Rachel L. Navarro:** Conceptualization, Methodology, Data curation, Writing – original draft, Supervision, Project administration, Funding acquisition. **Bo Hyun Lee:** Formal analysis, Investigation, Data curation, Writing – original draft. **Xiaotian Hu:** Formal analysis, Investigation, Data curation, Writing – original draft. **David Diaz:** Investigation, Writing – original draft. **Leticia Martinez:** Investigation, Writing – original draft.

Declaration of competing interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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