Social Cognitive Predictors of Adjustment to Engineering by Underrepresented Students

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Abstract

We tested an integrative model of academic adjustment in a sample of 1377 engineering students. The model, which combined elements of the social cognitive models of interest, choice, satisfaction, and performance, specified the ways in which social cognitive variables and trait positive affect jointly promote academic satisfaction and persistence outcomes. A key feature of the model is the hypothesized interplay between interest and satisfaction variables in attracting students to and retaining them within the engineering academic environment. The model generally offered good fit to the data both in the larger sample and in sub-samples of women, men, and students of racial/ethnic groups that are differentially represented in engineering.

Introduction

A recurrent theme in government and industry circles in recent years – and one well-documented in the popular press – involves the need to attract and retain more workers within science, technology, engineering, and mathematics-related (STEM) fields (e.g., Committee on Science, Engineering, and Public Policy, 2006). Vocational psychology researchers have long been concerned with factors that promote or impede STEM career paths and, in recent years, social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994, 2000) has offered one theoretical platform for such inquiry.

SCCT was originally composed of three segmental models focusing on (a) how basic academic and career *interests* develop, (b) how educational and career *choices* are made, and (c) what factors affect academic and career *performance* and persistence. More recently, a fourth model was added to help explain the factors responsible for educational and occupational *satisfaction* as well as other aspects of positive adjustment to school and work contexts (Lent & Brown, 2006, 2008). The latter model specifically attempts to elucidate the interplay between cognitive, behavioral, contextual, and personality factors within the process of educational and vocational adjustment.

A recent series of studies by Lent and colleagues has found that SCCT helps to account for the interests and major choice goals of female and male students in engineering (Lent et al., 2003; Lent, Brown, et al., 2005) and the computing disciplines (Lent, Lopez, Lopez, & Sheu, 2008), in both historically Black and predominantly White universities. Other researchers have also tested the SCCT choice model in racial/ethnic minority samples majoring in engineering and other STEM fields (e.g., Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010). Perhaps owing to its newness, the SCCT

satisfaction model has thus far been studied in only one STEM (engineering) sample (Lent, Singley, Sheu, Schmidt, & Schmidt, 2007).

The current study had two primary purposes. First, it was designed to combine elements of all four of SCCT's segmental models into a *connective* model, that is, a model that examines how these elements may operate jointly to predict the academic adjustment of engineering majors. Second, it was intended to build on and extend prior research testing SCCT with STEM majors. In particular, we sought to assess the adequacy of the connective model in samples of women and men and in underrepresented racial/ethnic minorities (African and Hispanic American students) as well as in racial/ethnic groups whose representation in engineering either approximates or exceeds their proportion of the U.S. population (European and Asian Americans) (NSF, 2008). While it is useful to test SCCT in samples of STEM students in general, group-specific tests are necessary to determine the range of the theory's cross-gender and cross-cultural validity and, potentially, to identify theory-derived methods for engaging and retaining more diverse persons in STEM fields.

Regarding the first purpose of the study (assembling and testing a connective SCCT model), we were particularly interested in addressing the interplay between interests and satisfaction as these two variables relate to persistence (or retention) in engineering. The linkage between interests and satisfaction reflects a long-standing topic of interest in vocational psychology (Hansen, 1984). Following convention, in SCCT interests are defined as the extent to which people like particular subjects or activities (e.g., "I like calculus"), whereas satisfaction may be defined as one's enjoyment of larger

life domains or roles that transcend and contain specific activities (e.g., “I am happy with my academic life”).

For the purposes of the current “connective” model (see Figure 1), we maintain that pursuit of one’s interests is likely to serve as a precursor to satisfaction with one’s academic major or job (path a). That is, being in an environment that allows one to express one’s primary academic or vocational interests should, all else being equal, lead to satisfaction with the environment. Both interests (path b) and satisfaction (path c) should, in turn, predict academic or vocational persistence because people tend to prefer to keep pursuing activities they like and to remain in environments that are satisfying. Findings support the linkage of interests to persistence (e.g., Lent et al., 2003; Lent, Brown et al., 2005) and of satisfaction to persistence (Dawis, 2005). What is less clear is whether the relationship of interests to persistence is fully mediated by satisfaction, or whether at least part of the relationship of interests to persistence is direct (i.e., above and beyond satisfaction). The remainder of the variables in the connective model, and the paths between them, are drawn largely from SCCT’s interest, choice, and satisfaction models. (For an explanation of the linkages between each of these predictors, their relations to work or educational satisfaction, and reviews of relevant research, see Duffy & Lent, 2009; Lent, 2008; Sheu & Lent, 2009).

In the current study, we examined the fit to the data of the connective interest-satisfaction-persistence model in a sample of students planning to major in engineering. The study represents a cross-sectional part of a larger longitudinal project aimed at examining the unfolding academic adjustment process in one STEM field. The overall goal of the project is to explore the interplay among theoretical elements that may

promote positive adjustment (defined in terms of satisfaction and persistence) over time – elements that could, in particular, inform interventions designed to attract and retain women and other underrepresented persons within STEM majors.

Method

Participants were 1377 students enrolled in introductory engineering courses at four state universities. Two of the four were predominantly White institutions (PWIs) and two were historically Black colleges/universities (HBCUs). Thirty-three percent (n = 458) of the participants were women and 67% (n = 927) were men (three students did not identify their gender). Ninety seven percent of the participants were first-year students; the mean age was 18.42, SD = 1.96. In terms of race/ethnicity, 808 of the students (58%) were European American, 208 (15%) were African American, 276 (20%) were Asian American, and 55 (4%) were Hispanic; the remaining 3% listed other racial/ethnic designations or did not report their race/ethnicity. Mean self-reported mathematics SAT scores were 674.98 (SD = 75.04).

Students were recruited for participation in the study via faculty members/research partners at each of the universities. Participants completed an online survey consisting of demographic and academic status questions, along with measures of self-efficacy, outcome expectations, social support, activity interest, academic domain satisfaction, and choice persistence goals relative to engineering. Each of these measures has been used in prior research (e.g., for information on the psychometric features of the measures, see Lent et al., 2003, 2007; Lent, Brown et al., 2005; Lent, Singley et al., 2005).

Results

To test the connective model hypotheses, we conducted a series of structural equation modeling analyses using the EQS 6.1 software package (Bentler & Wu, 2005). These analyses employed multiple observed indicators of each latent construct to control for measurement error. The path model shown in Figure 1 is based on the assumption that the seven constructs in the model represent separate but correlated latent dimensions. To test this assumption, we first ran measurement models (confirmatory factor analyses) examining the fit of a seven-factor representation of the latent constructs. Once the measurement models were tested, structural models were examined to assess the extent to which the hypothesized paths among the constructs in Figure 1 were consistent with the data.

Full Sample Analysis

Table 1 summarizes the fit indices for all measurement and structural model tests. The seven-factor measurement model produced acceptable fit to the data in the full sample. The structural model also yielded acceptable fit. As shown in Figure 2, support was found for nearly all of the hypothesized paths. The only non-significant paths were the ones from outcome expectations directly to satisfaction and from interests directly to persistence. Outcome expectations were linked to satisfaction indirectly through interests, and interests were linked to persistence indirectly through satisfaction.

On balance, interest, satisfaction, and intended persistence were each well-predicted by their hypothesized paths (R^2 = .45, .59, and .41, respectively). Students were more likely to express satisfaction with the engineering domain to the extent that they felt efficacious at and interested in engineering activities, perceived support for pursuing this major, and generally experienced positive affect. They were more likely to intend to

persist in engineering if they were satisfied with the environment, and reported high self-efficacy and favorable outcome expectations.

Sub-Sample Analyses

We next examined the fit of the measurement and structural models separately for women, men, and the three largest racial/ethnic groupings in our sample.

Model fit by gender. As shown in Table 1, the measurement model fit the data well within the separate sub-samples of women and men, supporting the 7-factor representation of the constructs. The structural model, testing the hypothesized paths among constructs, also achieved adequate fit in each group.

The pattern of significant paths generally paralleled that of the full sample test (see Figure 3), with the only difference being that outcome expectations produced a significant direct path to persistence among males but not females. (It should be noted, however, that these differing path coefficients were not very different in relative terms and the sample size for males was roughly twice that for females, making for greater statistical power in the former group.) The analyses accounted for large amounts of the predictive variance in the key dependent variables, satisfaction and persistence, in both genders – but somewhat more so in the female than male sub-samples (for satisfaction, R^2 = .70 in women and .55 in men; for persistence, R^2 = .49 in women and .38 in men).

Model fit by racial/ethnic group. Finally, we examined model fit separately within the European American, Asian American, and combined African and Hispanic American sub-samples. As shown in Table 1, the measurement model achieved adequate fit to the data in each sub-sample. Separate tests of the structural model in each group

also produced adequate fit for European Americans and African/Hispanic Americans; the fit indices for Asian Americans were somewhat less optimal though still acceptable.

Figure 4 contains the path coefficients for each of the racial/ethnic sub-samples. There are a few differences among the groups in terms of the significance of path coefficients predicting satisfaction and persistence. In particular, self-efficacy produced a significant direct path to satisfaction, and outcome expectations produced a significant direct path to persistence, only in the European American group. In addition, the direct path from satisfaction to persistence was significant in the European and African/Hispanic sub-samples but not in the Asian sub-sample. However, once again, these few differences should be viewed tentatively because of disparities in the sample sizes (and, hence, statistical power) and the fact that tests of model invariance across groups have not as yet been conducted. The SCCT model accounted for relatively large yet varying amounts of predictive variance in the primary dependent variables, explaining somewhat more variation in interests and persistence in the European American and African/Hispanic American groupings than in the Asian American sub-sample (for interests, R^2 = .52, .50, .31, respectively; for persistence, R^2 = .44, .48, .33).

Discussion

The present study examined the tenability of a “connective” model integrating elements of SCCT’s interest, choice, satisfaction, and performance models. The findings generally provide initial support for the connective model among students planning to major in engineering. In particular, we found that interests were predictive of students’ academic domain satisfaction. Students were also more likely to be satisfied with engineering to the extent that they felt confident in their academic skills, perceived they

had sufficient environmental support for remaining in engineering, and had higher levels of positive affect. Further, we found that students who were more satisfied with the academic environment in engineering were, in turn, more likely to report intentions to persist with this major. These findings are consistent with the satisfaction-tenure hypothesis in the theory of work adjustment (Dawis, 2005), prior findings on the relation of job satisfaction to turnover/persistence intentions in workers (Brief, 1998), and our own previous results linking satisfaction to intended persistence in engineering students (Lent et al., 2007). Intended persistence has, moreover, been found to be a very good predictor of actual persistence in engineering majors (Lent et al., 2003).

An important goal of the study was to examine the adequacy of the SCCT-based connective model in particular gender and racial/ethnic sub-samples. Our findings indicated that the model fit the data well in both female and male sub-samples. On all but one path (from outcome expectations to persistence), the analyses produced the same pattern of significant path coefficients in the male and female groups. However, the coefficients on this path were not substantially different in a practical sense, and the difference in statistical significance was likely due to the disparate sizes of the two sub-samples. Importantly, the analyses revealed that, while the same model fit the data for both gender groups well, it accounted for a larger proportion of the variation in women's than men's academic satisfaction and persistence intentions.

The connective model also provided acceptable fit to the data in separate sub-samples of European, Asian, and African plus Hispanic American students. The latter sub-sample consists of students who are underrepresented in engineering, while the other two are either adequately or over-represented relative to their proportions in the general

population. Despite the adequate model-data fit for each group, we did observe two instances in which a path was significant in the European American group but not in the other two groups (self-efficacy to satisfaction, outcome expectations to persistence), and one instance in which a path was significant for the European and African/Hispanic American groups but not in the Asian American group (satisfaction to persistence).

The study's findings need to be interpreted in light of its limitations. First, we have not yet tested the invariance of model fit across gender or race/ethnicity; therefore, caution is warranted in concluding that there are, or are not, meaningful differences in model adequacy or path coefficients as a function of the grouping variables. Second, only one aspect each of personality (positive affect) and environmental (social) support were included in the study. While these measurement decisions were made partly for pragmatic reasons (i.e., to contain model complexity), it is possible that additional trait dimensions (e.g., conscientiousness) and aspects of supports (e.g., extent of financial resources) could provide a fuller picture of the academic adjustment process. Third, we need to highlight that the models were tested with cross-sectional data. Therefore, while the findings were generally consistent with theoretical expectations, the study's design cannot support causal inferences regarding the determinants of interest, satisfaction, or intended persistence. The present report is, however, part of a larger longitudinal project which will eventually permit closer examination of the hypothesized temporal precedence among the constructs.

These limitations imply several directions for future research on academic adjustment from a social cognitive perspective. First, it would be useful to replicate and extend our findings on the interplay of interests and satisfaction with other samples of

students planning to major in STEM fields. In particular, it would be useful to test our hypotheses regarding their differential roles, with interest serving as a primary attractor to STEM majors and satisfaction serving as the more proximal determinant of whether students persist in these majors. Second, more research is needed specifically testing the explanatory utility of SCCT across gender, race/ethnicity, and university type. Such work is important in order to determine the range or limits of the theory's applicability (e.g., is it a generally useful framework or does it account for academic and career adjustment processes more adequately in particular groups of students and less adequately in others)?

Finally, the connective model tested in this study highlights antecedents of satisfaction and persistence that, theoretically, are susceptible to educational interventions. Although implications for practice need to be offered cautiously, the current findings suggest that efforts to identify and bolster needed supports may contribute directly to self-efficacy, outcome expectations, and satisfaction within the academic environment and, hence, increase the likelihood of retention. Some of these environmental resources could be offered via organization of student support programs (e.g., living-learning programs, tutoring, mentoring), while others may involve efforts to structure learning activities in ways that are likely to optimize self-efficacy and promote realistic but favorable outcome expectations.

In sum, the present findings extend social cognitive inquiry on person and environment factors that may promote or deter choice of, and persistence in, engineering majors. We found support for a connective model that weaves together elements of SCCT's interest, choice, satisfaction, and performance models – both in the larger sample and in sub-samples of women and men and in students of racial/ethnic groups that are

differentially represented in engineering. Further research is needed to test the model's explanatory value as well as to assess the utility of efforts to apply it to educational/career assessment and intervention.

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