AC 2011-1766: RACIALLY DIVERSE WOMEN'S AND MEN'S ADJUSTMENT TO STEM MAJORS: IMPLICATIONS FOR RECRUITMENT AND RETENTION

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Racially Diverse Women's and Men's Adjustment to STEM Majors: Implications for Recruitment and Retention

Abstract

This study of 245 racially diverse engineering students extends prior social cognitive career theory[1] research by examining social-contextual and personal factors that promote successful adjustment. Participants reported experiencing several types of academic, social, and financial hurdles during their first semester. They also described factors that facilitated their academic progress and additional elements that, if available, could have further assisted their adjustment. Implications for research, recruitment, and retention will be discussed

Introduction

Government planners, industry groups, and academics all have expressed concern about the need to attract and retain more racially diverse students and workers within science, technology, engineering, and mathematics-intensive (STEM) fields[2,3]. Not surprisingly, over the past several years, researchers have employed a number of theories and methodologies to further elucidate the academic and career development experiences of racially diverse students in STEM fields.

One theoretical approach that has been applied to understanding the factors that attract students to, and that affect their persistence within, STEM fields is social cognitive career theory[1] (SCCT). SCCT originally focused on three key aspects of academic and career development: (a) how basic academic and career *interests* develop, (b) how educational and career *choices* are made, and (c) what factors affect academic and career *success* (i.e., achievement and persistence). SCCT is based on Bandura's[4] more general social cognitive framework – an influential theory of cognitive and motivational processes that has been extended to the study of many areas of psychosocial functioning. More recently, SCCT has been expanded to illuminate the factors responsible for educational and occupational *satisfaction* and other aspects of positive adjustment to school and work contexts[5,6].

SCCT offers a useful perspective from which to understand and promote the career development of racially diverse students in STEM fields. A theory-based approach also may lend added coherence, organization, and comprehensiveness to current STEM workforce development efforts, including efforts to understand the role of gender, race/ethnicity, and other individual difference factors in choice of, and persistence in, STEM fields. For instance, knowledge of such issues as students' developmental needs and tasks at various ages, the cognitive mechanisms through which educational intervention effects operate, or the social-contextual factors (e.g., family and peer supports or discouragement) that facilitate and constrain choice options for particular groups of students could be quite beneficial to STEM workforce preparation efforts. Yet to this point, the career development literature has been largely underutilized as a wellspring for STEM workforce development planning.

While it is useful to test SCCT using *nomothetic*, quantitative methods, it is valuable to complement such research with *idiographic*, qualitative methods capable of elaborating specific self and environmental percepts that could inform educational interventions. For example, prior work on SCCT has established that social supports and barriers generally have been linked to persistence in engineering majors (largely indirectly, through their relation to self-efficacy), but the mostly nomothetic research on this issue has focused on global aspects of supports and barriers. Idiographic (i.e., more individually-oriented) research could identify which specific aspects of supports and barriers are experienced as crucial to racially diverse students in STEM majors, and what coping resources they use more or less effectively to negotiate barriers to their academic persistence.

In sum, this study extends prior research on SCCT in the context of racially diverse students' STEM field choice and persistence. Specifically, by employing qualitative methods, we explored the environmental barriers experienced by racially diverse students entering engineering majors, along with the environmental resources and coping strategies that help them to negotiate these barriers. The advantage of this discovery-oriented methodology is that it enabled us to explore students' experiences from their own phenomenological perspectives.

Method

Participants were 245 racially diverse women (n = 73) and men (n = 172) enrolled in their first year of engineering at three East coast universities on the East coast with large engineering programs. Mean age for the sample was 18.20 (SD = .76). Participants identified as Asian American (n = 125), Black/African American (n = 73), Hispanic/Latina/Latino (n = 29), Native American/American Indian (n = 2) and "other" (n = 16).

Incoming first-year engineering students were invited to participate in a mixed-methods study of adjustment to engineering majors. Online data collection was conducted during the last four weeks of the 2008 fall semester. Students were offered a gift card for their participation. The online survey included both a battery of structured measures for formal theory-testing purposes, and a set of seven open-ended questions for discovery-oriented purposes. The questions asked about (a) major hurdles faced during the semester, (b) how students coped with the identified hurdles, (c) additional resources that might have helped students cope, (d) positive factors that impacted progress and persistence, (e) experiences, events, and people that impacted students' confidence, (f) positive expectations associated with degree attainment, and (g) sources of these positive expectations within the context of engineering field choice. To reduce participant burden, we assigned students either questions one through four or five through seven. The responses were reviewed and coded by a team of doctoral students (n = 5) and faculty (n = 2) in counseling psychology.

We used common content-analysis methods[7] to code participants' responses. We also incorporated aspects of the consensual qualitative research paradigm[8]; specifically, we used a consensus-driven process to arrive at final coding decisions. First, for each question, participant responses were unitized such that each individual thought unit within an individual response was identified; thus it was possible for one response to include multiple thought units. Second, each research member individually reviewed all participant responses and then developed a tentative list of categories and subcategories to encompass them. Third, the entire coding group met to discuss and eventually come to consensus regarding response categories and subcategories.

Fourth, approximately 5% of participant responses from each of the four questions were selected in order to conduct coder training. Fifth, the entire group met again to further discuss and finalize the list of categories and subcategories. Next, the five students were divided into 10 two-member coding teams. Each team coded one-fifth of the participant responses. Each member of the dyad coded the responses independently, placing each thought unit into the most appropriate category and sub-category. Dyad coding consistency was then evaluated by another research team member. Any coding inconsistencies were resolved through consensus.

Results

Our first research question asked about the major hurdles or challenges that students faced during their first semester and whether these challenges hindered academic success or willingness to continue in engineering. Participant responses reflected five broader categories including academic-internal, academic-external, social, financial, and health barriers. Common *academic-internal* (i.e., intrapersonal) *barriers* included student disinterest (e.g., in course material), negative affect (e.g., feeling overwhelmed or frustrated), problems with academic, organizational, and developmental skills and adjustment (e.g., time management, academic performance problems, negotiating competing demands), and career indecision. Common *academic-external barriers* were program and university barriers (e.g., difficulties with registration), and problems with instructors, teaching assistants, and advisors (e.g., difficulty understanding instructors' speech patterns, poor advising). One relatively infrequent, but perhaps important reported academic-external barrier for women was the lack of representation of other women enrolled in the engineering program. Common *social barriers* were lack of social support, lack of friends in the major, and relationship problems. The primary *financial and health barriers* were tuition costs and sickness, respectively.

Our second question asked about the coping strategies that participants employed to deal with the hurdles they had experienced. The first category was labeled *social interactions* and referred to the peer, familial, professional, and romantic relationships participants used to cope with challenges. One important finding was that a number of women indicated that seeking support from other women engineering students was helpful in dealing with the challenges associated with their underrepresented status. Using *personal resources* was another coping strategy and referred to participants' own character qualities, skills, attitudes, and perceived abilities employed to cope with the challenges. The final two categories were *academic and non-academic resources*. Common academic coping strategies were seeking assistance from instructors, participating in academic programs (e.g., living-learning and mentoring), and seeking academic assistance (e.g., tutor and review sessions). Some common non-academic coping strategies were getting involved with non-engineering student organizations, self-care (e.g., exercise), pursuing sources of funding, and spiritual and religious practices.

The third question asked participants to identify any additional resources that, if available, would have helped them to cope with the challenges faced during the semester. Participants indicated that increased *social support* would have helped. Participants also stated that *academic – teaching adjustments* (e.g., improved instruction, revising course materials to increase interest) and additional *academic resources* (e.g., mentoring programs, theme housing, information and test review sessions, increased office hours, access to writing centers, technical assistance with computers) would have been beneficial during the semester. In addition, some participants felt that *personal adjustments* (e.g., being more organized or assertive in seeking assistance from instructors, putting forth more effort) and engaging in *extracurricular activities and resources* (e.g., religious activities, sports, exercise) would have been helpful when coping with the semester's challenges.

Our fourth question asked about the presence of any positive factors that affected academic progress or willingness to persist in engineering during the semester. Participants' responses reflected five categories of positive factors including social support, departmental and university support, non-academic organizations, personal resources, and academic interest. Positive *social support* experiences with friends, peers, study groups, family members, mentors, and romantic partners were all listed as facilitating academic progress. In addition, connecting with other members of underrepresented groups (i.e., gender) in engineering was also mentioned. A majority of participants indicated that *departmental and university support* such as mentoring and summer orientation programs, theme housing, honors society, academic assistance programming (e.g., teaching assistants who go above and beyond the call of duty, information sessions, tutoring, writing center, workshops, online materials) also facilitated their academic progress. *Personal resources* (e.g., performance accomplishments, short and long-term expectations, stress management, traits such as motivation, and study skills) and *interest* in engineering were also helpful in facilitating academic progress. Positive experiences with *non-academic organizations* such as religious, military, and non-engineering student organizations were also mentioned.

Our fifth question asked about any experiences, events, and/or people that had the most impact – positive or negative – on students' confidence to complete an engineering degree. Participants' responses reflected five factors including performance experiences, modeling and social support, teaching and course quality, intrapersonal, and interest match or mismatch. *Performance experiences* were a frequently cited factor and included personal success ("solve an engineering problem") and peer comparisons ("if that person can… I can"). Similarly, *modeling and social support*, was frequently reported and consisted of encouragement/discouragement ("parents… assuring me that I could do anything") and modeling (e.g., inspired by work of others perceived to be similar). *Teaching and course quality*, not surprisingly, were also cited by many participants and related to instruction and content. Participants also reported that *intrapersonal* factors such as motivation ("I am determined to earn my degree") and *interest match or mismatch* impacted confidence.

When asked about the most important positive outcomes they hope to receive as a result of earning an engineering degree, participants' responses generally represented three categories including attractive intrinsic work conditions, extrinsic work benefits, and civic engagement. *Attractive intrinsic work conditions* refer to aspects of work or the work environment that are in themselves fulfilling; examples include the opportunity to apply knowledge, create something, or do innovative and challenging work. *Extrinsic work benefits* include financial stability and increased professional and educational opportunities. Finally, many participants referred to *civic engagement* (e.g., "giving back to the community" and participating in environmentally focused work).

Our final question asked participants to identify what sources of information they had used as a basis for their positive expectations about earning an engineering degree. Participants reported *social* (e.g., peers, family, advisors, and engineers), *institutional* (e.g., onsite tours, camps, information session, clubs, and courses), *media* (e.g., print, TV, and online outlets), *personal experiences* (e.g., personal exploration, interest, skills, prior work experience, and pre-college experiences) as sources of positive outcomes.

Finally, some participants identified a number of culture and gender specific issues that impacted their adjustment to STEM. First, some female participants reported experiences of sexism ("boys that think they are smarter than me and don't take my opinion") and underrepresentation ("being the only girl in my workshop class"). Female participants also found that formal programs (e.g., SWE, sororities, and living and learning programs) helped them to bolster their confidence and overcome hurdles. Racially diverse international students reported financial, language, and cultural difference factors to their adjustment during the first semester in engineering.

Discussion

We employed a semi-qualitative methodology to elucidate racially diverse engineering students' experiences of academic adjustment in engineering. Our participants reported (actual percentages will be reported in the presentation) experiencing several types of academic (e.g., study skill deficits), social (e.g., lack of support), and financial (e.g., tuition) challenges to their academic progress during their first semester. They also described several factors that facilitated their progress – such as university programs (e.g., mentoring, living-learning housing), social support from peers, and development of personal resources (e.g., time and stress management skills) – as well as additional elements that, if available, could have further assisted their adjustment.

Given the numerous challenges faced by study participants, we offer the following recommendations for program administrators and faculty, with the hope of facilitating the retention of racially diverse students in engineering. First, the findings suggest that in order to address issues faced by these students, it might be beneficial to focus on both external/environmental and intrapersonal academic barriers. For example, when addressing internal academic barriers, it might be important to normalize negative feelings (e.g., frustration and feeling overwhelmed) experienced during the first semester. In addition, it might be helpful to provide resources (e.g., peer advising and support from advanced students) to help students cope as they transition into the major. Indeed, the literature on modeling suggests the particular value of "coping models" (e.g., more experienced women students who have themselves coped successfully with first-year challenges). Such peer models can offer both support and credible coping advice.

Second, providing workshops to teach time management and study skills may help many students to achieve academic success and remain in engineering. One of the most frequently endorsed external academic barriers was the poor quality of certain aspects of instruction and course curriculum. Based on the present findings, it seems that supplying supplemental course materials and additional course review sessions might help students who have difficulty comprehending material and those who have difficulty understanding their course instructors. Faculty might also be sensitized to the need to communicate clearly and to present course material in ways that cultivate and maintain students' interest.

Third, given the central perceived role of social support in bolstering persistence in engineering, program administrators and faculty advisors might consider ways to more systematically organize social support systems for students – both prior to entering and throughout the program. For example, one strategy might be to provide resources (e.g., meeting rooms) and leaders for extracurricular social, mentoring, and networking events. Also, it might be beneficial to provide targeted support for racially diverse students such as an ongoing workshop in which academic, professional, and interpersonal issues are discussed.

Finally, given our findings regarding the positive impact of peers and classmates, when recruiting racially diverse engineering students, it might be beneficial to conduct information sessions led by demographically similar advanced students and alumni. Hearing how racially diverse women and men succeeded in engineering might enhance the engineering-specific self-efficacy beliefs and outcome expectations of racially diverse applicants.

It is important to note that given the qualitative nature of the study, the generalizability of findings to all racially diverse students in engineering is limited. Causal inferences would also be premature. Finally, the experiences of our study participants might not reflect the experiences of racially diverse students in other engineering programs across the country.

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