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STEM MOTIVATION AND PERSISTENCE AMONG UNDERREPRESENTED MINORITY STUDENTS

A Social Cognitive Perspective

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Significant national efforts have been made during the last three decades to increase the number of underrepresented minority (URM) students in science, technology, engineering, and mathematics (STEM) disciplines, yet only modest increases have been realized. The sociopolitical and historical dimensions of minority students' underrepresentation in higher education and STEM in particular are complex. Minorities were largely and systemically excluded from educational opportunities during much of the 20th century, creating a stubborn gap in educational attainment between minority and White students in STEM higher education that continues to this day (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011). While this gap has narrowed somewhat in recent decades, the challenges faced by URM students pursuing undergraduate STEM degrees have been described as unique and persistent (Chang, Sharkness, Hurtado, & Newman, 2014).

Many national calls to action to increase the diversity in the national STEM workforce have been asserted in recent years. National economic competitiveness and security are often cited as driving forces for diversifying URM students studying STEM disciplines and subsequently helping meet projected workforce demands. The effect of the historical marginalization of URM students in STEM is compounded by the anticipated high retirement rates in the current STEM workforce and declining STEM enrollments (Carnevale, Smith, & Milton, 2011; Drew, 2011; National Academy of Sciences et al., 2011; National Action Council for Minorities in Engineering [NACME], 2012).

A key report published in 2011 by the National Academy of Sciences emphasizes diversity as both a societal and economic resource. They call for broadened participation in STEM by examining the issue from an opportunity cost perspective, asserting that the United States can no longer afford to waste the

participation and viewpoints of URM^s (National Academy of Sciences et al., 2011). The potential human capital gained by greater participation of URM^s in STEM will not only increase the number of citizens participating in the STEM workforce, but also widen the diversity of thought that will ultimately strengthen the solutions that the workforce will be able to develop in response to today's complex problems for a diverse society (National Academy of Sciences et al., 2011). A well-known example of a problem in overlooking diversity in a STEM setting is the predominantly male engineering team that designed the first generation of automobile airbags that were designed based only on men's body sizes; these airbags therefore deployed at forces that increased injuries and fatalities for women and children passengers (Margolis & Fisher, 2002).

The abovementioned national calls to action are concomitant with the changing domestic U.S. talent pool, in which African American and Hispanic/Latino groups are the fastest growing populations. The U.S. Census Bureau predicts that by 2030, these two groups will comprise 34% of the population. As of yet, African Americans and Latinos represent a small fraction of students pursuing undergraduate STEM degrees, for example, making up only 5% and 3.8% of undergraduate engineering students, respectively (not including Puerto Rico). However, their 2013 representation in the overall population is estimated to be 14.3% and 17.4% of the United States, respectively (Colby & Ortman, 2015; NACME, 2012; Yoder, 2012). The rising population predictions suggest that large increases in the numbers of African American and Hispanic students studying STEM subjects will be needed even if we are only to maintain current proportions in undergraduate education.

As such, a number of theoretical approaches and research studies have been conducted to understand influences on URM^s' persistence and achievement in STEM. We focus this chapter specifically on social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994; Lent et al., 2015). SCCT identifies social and psychological factors that play a major role in whether students succeed and persist in subjects and careers. Several facets of personal motivation stemming from socializing agents predict academic and career outcomes related to achievement, choice, and persistence. A subset of this research has focused on URM students in STEM, which has led to the exploration of additional cultural and contextual influences on motivation that are salient in these students' lives (e.g., Lent et al., 2001). This subset of research will be the focus of this chapter. First, we will briefly discuss how this theory is informed by social cognitive theory (Bandura, 1986) and explain the major motivational constructs within SCCT. Second, we will highlight several of the personal, cultural, and contextual factors that have been studied as predictors of STEM motivation among URM students.

Social Cognitive Career Theory

Through a social cognitive theoretical perspective, people are neither solely motivated by internal influences nor regulated by environmental factors. Instead,

environmental factors, person factors (e.g., cognitive states), and behavior jointly influence each other in a reciprocal manner (Bandura, 1986). Lent and his colleagues (1994) explicitly apply Bandura's (1986) social cognitive theory in their comprehensive SCCT model to explain career development processes. Within SCCT, models of interest, choice, satisfaction, and performance have typically been examined as separate segments, although more recent work has identified the advantages of combining components into an integrative model (Lent et al., 2015). The main variables in SCCT related to student motivation are self-efficacy, outcome expectations, and interest. These variables act as mediators linking personal and environmental factors to subsequent career decisions and outcomes.

Self-Efficacy

Self-efficacy is defined as "a judgment of one's capability to accomplish a certain level of performance" (Bandura, 1986, p. 391). SCCT researchers examining self-efficacy beliefs among URM students have measured self-efficacy pertaining to several academic domains and outcomes, such as mathematics, science (Anderson & Ward, 2014), college completion (Flores, Navarro, & DeWitz, 2008), and career decision making (Gushue & Whitson, 2006). Studies have indicated that URM students with higher self-efficacy for math and/or science are more likely to have goals to persist and have higher academic performance within these domains (Austin, 2010; Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Else-Quest, Mineo, & Higgins, 2013; Gainor & Lent, 1998). Thus, it is important to understand the antecedents of students' self-efficacy beliefs to understand URM students' likelihood of persisting in STEM.

Consistent with Bandura's (1986) social cognitive theory, SCCT highlights four major sources of self-efficacy that stem from a person's learning experiences: prior mastery experiences, verbal persuasion, vicarious learning (models), and affective and physiological reactions. Previous researchers have noted how these sources of self-efficacy may manifest themselves differently in the lives of URM students compared to their White counterparts given, for example, the differential performance feedback and educational inequities experienced by students of color (Hackett & Byars, 1996; Johnson-Ahorlu, 2012; Lent et al., 1994). These contextual influences on URM students' self-efficacy will be elaborated further in subsequent sections.

Outcome Expectations

Related to a person's self-efficacy beliefs are outcome expectations, which are judgments of the likely outcomes (e.g., rewards or punishments) that are obtained from engaging in specific behaviors (Bandura, 1986). For example, students may anticipate certain outcomes for performing well, such as praise from teachers and parents. These anticipated consequences are separate from students' beliefs in their capability to do so (Bandura, 1986); outcome expectations and self-efficacy

work jointly to influence career-related interests and outcomes (Lent et al., 1994). However, Bandura (1986) suggests that outcome expectations play a weaker role in determining behavior. For example, people may anticipate positive outcomes from successfully performing a particular activity, but if they have doubts about their capability to do so, outcome expectations may serve as a poor determinant for engaging and persisting in that activity (Bandura, 1986).

Researchers have noted that the outcome expectations for engaging in certain academic or career-related activities among URM students may be markedly different from their White peers, based on the systemic structural inequalities and discrimination that still exist in American institutions. Because URM students may perceive their efforts as not having the same outcomes as students from other racial and/or ethnic groups, their likelihood to persist in certain academic and career-related activities may diminish. Thus, despite valuing education, if the anticipated consequences of succeeding in educational domains are not equally rewarded, these perceptions may affect motivation, performance, and persistence (Hackett & Byars, 1996).

Interest (Values)

In addition to self-efficacy, Lent et al. (1994) indicate that personal values play an inherent role in the extent to which outcome expectations are determinants of behavior. Specifically, in order for outcome expectations to have an influence on career behavior, one must value the anticipated consequence of enacting a particular career-related activity. SCCT focuses on a form of value-labeled interest, defined as “patterns of likes, dislikes, and indifferences regarding career-relevant activities and occupations” (Lent et al., 1994, p. 88). Interests are posited to be influenced by both self-efficacy and outcome expectations. Individuals develop stronger, long-lasting interests in activities for which they both believe they can succeed and expect positive outcomes. The assertion that self-efficacy and outcome expectations influence interests and, in turn, academic goals, has been found to generalize to the career development of URM students (Byars-Winston et al., 2010).

Researchers have noted that because of the varying influence of culture and socializing agents on identity, one might expect that students' value and interest for engaging in certain academic and career domains would differ across racial/ethnic groups (Anderson & Ward, 2014). For example, because racial and ethnic stereotypes are pervasive in our culture, it is not surprising that URM students' awareness of these stereotypes plays a role in shaping their identity, which can in turn influence the extent to which they value STEM disciplines and careers (Aronson & McGlone, 2009; Hudley & Graham, 2001; Sinclair, Hardin, & Lowery, 2006). In addition, URM students may be less likely to see themselves as a math/science person or as someone “fitting” in to the STEM profession, as they are not typically exposed to people of the same racial/ethnic background working in

STEM careers (Seymour & Hewitt, 1997). Recent findings provide support for this contention, as one particular study indicated that among high-ability ninth-grade students, White students valued science more than did their Black and Hispanic peers (Anderson & Ward, 2014).

Personal, Cultural, and Contextual Influences Within SCCT

In addition to the main psychological components of SCCT, researchers recognize the importance of personal and contextual influences on learning experiences and, in turn, motivational processes within the models (Lent et al., 1994). These components include person inputs, which include race/ethnicity, as well as background contextual affordances and more proximal contextual influences, such as supports and barriers (Lent, Brown, & Hackett, 2000; Lent, Sheu, Glosster, & Wilkins, 2010). The next several sections will review some of these influences and provide examples of research examining the extent to which these variables influence URM students' STEM motivation.

Person Inputs

Lent et al. (1994) highlighted the importance of including "developmental models of race/ethnicity/culture" (p. 118) to understand how the special issues and challenges that come with minority membership play a role in the career development of URM students. Accordingly, the focus of SCCT research has included attempts to understand how sociocultural factors can influence students' perceptions of themselves and, in turn, their academic and career attitudes. SCCT studies have examined both racial and ethnic identity and the developmental stages of these identities as influences on students' motivation for pursuing STEM (Gainor & Lent, 1998).

Racial and Ethnic Identity

Racial identity is defined as "the significance and qualitative meaning that individuals attribute to their membership within the . . . racial group within their self-concepts" (Sellers, Smith, Shelton, Rowley, & Chavous, 1998, p. 23), whereas ethnic identity centers more on the extent to which one identifies with "the culture of one's ancestors' national or tribal groups" (Helms, 1994, p. 293). Researchers have used these terms interchangeably (Yip, Douglass, & Sellers, 2014), and various theoretical conceptualizations of these two forms of identity have been examined in relation to STEM motivation among URM students. Therefore, it is difficult to synthesize previous research to develop a comprehensive understanding of the extent to which racial and ethnic identity influence students' motivation to pursue STEM fields. Nevertheless, we will summarize the various

Navarro, Smith, & Ploszaj, 2006; Flores & O'Brien, 2002), whereas others have used the scores on each dimension as separate continuous variables to determine if a person is highly orientated in each respective dimension (Flores & O'Brien, 2002; Flores et al., 2008; Garriott & Flores, 2013; Navarro et al., 2007). Nevertheless, findings from Navarro et al. (2007) are somewhat consistent with other studies suggesting that higher levels of assimilation are associated with adaptive motivational processes (Garriott & Flores, 2013) and higher educational attainment aspirations and expectations (Flores et al., 2008). Some researchers have concluded that higher levels of assimilation may emerge as more adaptive because Mexican American students in the United States are typically immersed in educational environments where Anglo cultural values are predominant (Garriott & Flores, 2013).

Although Anglo orientation tends to emerge as more adaptive, the fact that the effects of acculturation on career-related motivational outcomes are small cannot be overlooked. These small effects may result from the way that acculturation status has been measured. Using Anglo and Mexican orientation as separate continuous variables may obfuscate the effect of biculturalism (high orientation to both dominant and heritage cultures) on motivation. Distinguishing biculturalism from other levels of acculturation in relation to STEM motivation seems particularly important for several reasons. First, results from a recent meta-analysis indicate that a consistent and strong association exists between biculturalism and psychological and sociocultural adjustment (Nguyen & Benet-Martinez, 2013). In addition, studies show that bicultural individuals are more proficient at adjusting to various people and environments both in the dominant culture and in their native culture, as well as other cultures (e.g., Leung, Maddux, Galinsky, & Chiu, 2008). This suggests that bicultural students of color who have adjusted to straddling two cultures may be better equipped to navigate educational and career systems in which they are the minority group, such as in STEM academic and career environments.

Background Contextual Affordances and Proximal Contextual Influences

According to SCCT, both objective and perceived environmental factors influence choice behaviors, with important consideration given to people's active sense making and response to positive and negative contextual influences (Lent et al., 2000). These environmental factors include both distal background contextual affordances (e.g., support or discouragement for participation in certain activities) as well as proximal contextual influences (e.g., career network contacts, external barriers). Supports and barriers exist at both temporal periods and are examined next.

Supports

The proximal contextual influences include the roles of socializers and others who may provide support, for example, through encouragement or endorsement

of academic and career choices. A variety of people have socializing influences on students. These individuals include parents, teachers, and peers. Parents are a child's first socializing agents; thus, the role of parents has been examined as critical influences on students' STEM motivation. For example, in Navarro et al.'s (2007) examination of Mexican American middle school students' mathematics and science goal intentions from a modified social cognitive career theory perspective, perceptions of parental support (e.g., "My parent(s) show that they are proud of me") significantly predicted math/science self-efficacy, which in turn was related to intentions to pursue and persist in mathematics and science courses in high school and future careers.

In a study examining an ethnically diverse sample of female engineering majors, social supports were assessed utilizing mixed methods, specifically, quantitative survey and qualitative interview methods (Trenor, Yu, Waight, Zerda, & Sha, 2008). Analysis of survey data indicated that social supports, including perceptions that family members supported their choice of major, were positively correlated with intentions to persist in engineering. Further, in the interviews, women reported family support and encouragement as influential in their pursuit of their career goals, although for the Hispanic students, the familial support was directed toward college completion in general and not a specific field. The benefits of social supports have also been demonstrated by Lent and colleagues (2001, 2003, 2005) in mathematics, science, and engineering with other college student samples.

In addition to parents' support, school personnel, including teachers, faculty, and academic advisors also provide important influences on students' motivation for STEM. Through their instruction and interactions with students, STEM teachers and faculty play direct roles in shaping students' motivation in those areas. For example, when students have success in the classroom, these mastery experiences can serve as a source of self-efficacy. Through the manner in which they teach STEM material and convey their own motivation for the subject matter during instruction, teachers and faculty can influence students' interests and attitudes toward those domains as well. Furthermore, teachers, faculty, and academic advisors can also provide support for STEM during out-of-class interactions. In an examination of a nationally representative cohort of 6,300 URM college student participants in the Education Longitudinal Study of 2002, Wang (2013) found that postsecondary academic interaction, which included talking with faculty about academic matters outside of class and meeting with one's advisor about academic plans, was directly related to choosing a STEM major. While the roles of parents and school personnel have been examined specifically, other adult influences also impact students' motivation in STEM. In some studies, researchers have investigated the possible influence of adults in general without specifying who these adults may be and the nature of their relationship with students. For example, in a study of mostly African American tenth graders in underserved communities, perceived adult support was positively related to intent

to pursue health science education in college, controlling for other cognitive, personal, and environmental factors (Zebrak, Le, Boekeloo, & Wang, 2013). In this study, extent of perceived adult support was assessed with self-report survey items such as, "I know adults who encourage me often in sciences" and "I have good adult science role models."

Barriers

Contextual influences include not only supports but also barriers. Barriers include environmental influences that can have a negative impact on students' motivation and achievement. For example, parents and teachers may discourage students from pursuing STEM. Trenor et al. (2008) found that for female undergraduates majoring in engineering, experiences with faculty were negatively related to perceived barriers to achieving college and career plans. In other words, the more that students indicated discussing with faculty things such as their academic program or course selection, the less pressure they felt to change their major to another field. These results were correlational, however, so causality cannot be determined.

In addition, racism creates barriers, both actual and psychological, that reduce students' opportunities to prepare for STEM careers (Alliman-Brissett & Turner, 2010). Using an extended SCCT framework, Alliman-Brissett and Turner (2010) investigated African American middle school students' perceptions of racism and several SCCT-related variables within the math domain. They found that several types of perceived racism were negatively related to math self-efficacy, math outcome expectations, math-related career interests, and academic achievement in math.

Johnson-Ahorlu (2012) conducted focus group interviews with African American undergraduates in order to explore how campus racial climate, particularly experiences of racism and stereotypes, influenced students' academic opportunities. Although from a critical race theory perspective and not SCCT, the findings are relevant to the previous study in that students recounted instances of faculty members demonstrating low expectations and lack of support for them because of their minority status. For example, one student indicated that faculty did not expect them to achieve and did not encourage them to go to graduate or professional programs because they did not feel they had the intellectual capabilities to succeed in those programs. Students reported being discouraged by faculty from majoring in certain undergraduate degree programs, which limited their academic opportunities and prevented them from pursuing their dreams and finding a suitable major (Johnson-Ahorlu, 2012).

To summarize, background contextual affordances and proximal contextual influences include both supports and barriers that are perceived at various times within the SCCT model. Both objective and perceived supports and barriers are included, which serve to encourage or constrain, respectively, the motivation and career-related processes among students.

Conclusions

In this chapter, we discussed SCCT with a specific focus on the personal, cultural, and contextual factors that influence motivation and academic and career outcomes in STEM for URM students. As a whole, research related to the role that racial/ethnic identity and acculturation has on URM students' STEM motivation has been mixed (e.g., Austin, 2010; Gainor & Lent, 1998). This may be due to inconsistencies in conceptualization and operationalization of these constructs. However, overall findings suggest that the extent to which the value of academic achievement is salient within one's racial/ethnic group identity may be an important predictor of STEM motivation among URM students beyond the centrality of race in one's identity. Also, positive feelings toward members of other racial/ethnic groups and being able to work with individuals outside one's racial and/or ethnic group has academic benefits when it comes to STEM persistence (Gainor & Lent, 1998).

Research related to contextual supports and barriers has been more consistent. For example, studies indicate that parental and teacher/faculty support positively influence motivation to persist in STEM among URM students (Lent et al., 2001, 2003, 2005; Trenor et al., 2008; Zebrak et al., 2013). Conversely, barriers such as discouragement and racism limit and constrain the motivation of URM students (Alliman-Brissett & Turner, 2010; Johnson-Ahorlu, 2012).

There are a number of recommendations for future research that can be made. First, more research needs to be conducted utilizing the established SCCT framework, but with a specific focus on URM in STEM. Although it was not possible to include every study that did fit these criteria in this review, it is notable that there were not many more studies available. Given the strength of this social cognitive perspective in understanding majority populations, it would be beneficial to see more work conducted examining URM students.

Relatedly, another suggestion is that researchers and educators should develop interventions aimed at addressing contextual factors that have been shown to positively influence motivation among URM students in STEM and then conduct evaluations of their effectiveness. For example, given findings that parental support is related to math/science self-efficacy and intentions to pursue and persist in these domains, programs that provide parent education on how to provide effective encouragement and support, as well as programs aimed at providing the support itself, could be very helpful for parents and students alike.

Through additional research investigations utilizing the established framework of SCCT, researchers and educators can continue to better understand the factors affecting URM students' motivation and pursuit of STEM courses and careers. More importantly, this work has the potential to allow educators, parents, and other important socializing agents to learn how to adequately support these students so that there are fewer differences in participation rates in the future. These changes are necessary if we are to address the projected workforce demands and provide a diverse talent pool capable of adequately tackling our society's technological and scientific problems.