

The Many Shapes of
Mentoring:

Women and Men of Color in
Undergraduate Science and
Engineering Education

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Mentoring Takes Many Forms

- The positive effect of mentor relationships for women, minority students, and women of color in science, technology, engineering, and mathematics (STEM) majors is well documented.
- Men and women of color tap into a host of networks including professors, graduate students, other undergraduates, university administrators, and professionals in *and* outside of their major field.
- Mentors don't necessarily share the same gender and racial/ethnic backgrounds as the students they support
- Mentoring has a major impact on how students develop their sense of self in college



2008 Academic Self-concept Study

Academic Self Concept:

- Consists of attitudes, feelings, and perceptions relating to one's academic or intellectual abilities

Lent, et al., 1997

- Self-perceptions have been shown to be better predictors of performance than objective measures of ability

Pajares & Miller, 1994; Hacket, et al., 1992; Gerardi, 1990

- Self-concept has been found to contribute to STEM career aspirations

Astin, 1993; Bonous-Hammarth, 2000; NRC, 2006



The Role of Self-perception in College Student Development

- Faculty attitudes and pedagogical practices are critical to students' cognitive and affective development

Astin, 1975, 1993; Pascarella & Terenzini, 2005

- The way in which individuals construct and use their knowledge is directly tied to their sense of self

King & Baxter Magolda, 2005

- Developing competence contributes to students' psychosocial development during college

Chickering & Reisser, 1993

- Student-faculty relationships and peer friendships exert powerful influence on student development

Evans, Forney, & Guido-DiBrito, 1998



Sample & Method

- UCLA Higher Education Research Institute (HERI) Freshman & College Senior Surveys: Graduation years 2001, 2002, 2003
- 463 women & 408 men from 148 four-year institutions
- 44% African American & 56% Latina(o)
- 45% biological and life sciences, 42% engineering, & 13% math and physical sciences
- Ordinary Least Squares Regression (OLS)



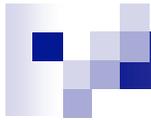
Self-concept Pre- and Post-Test

- Dependent variable & pre-test - factor of five items:

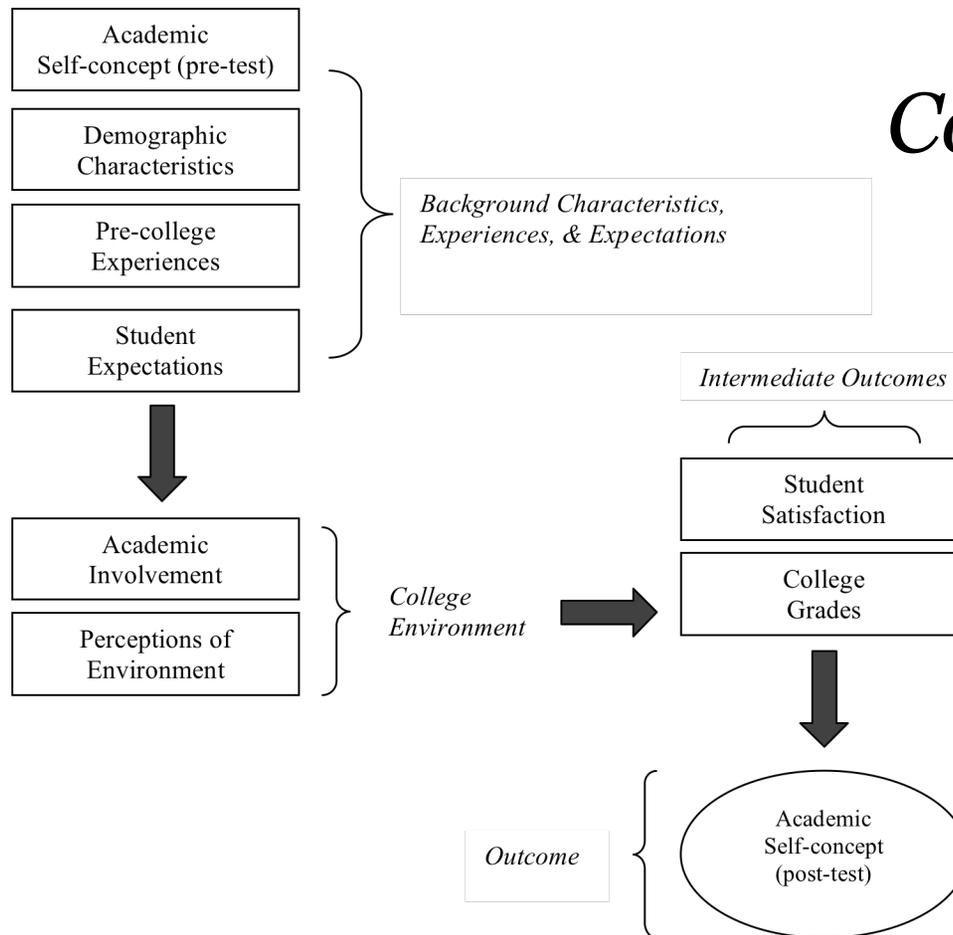
- Academic ability
- Mathematical ability
- Drive to achieve
- Intellectual self-confidence
- Writing ability

Cronbach's Alpha of both pre and posttest: 0.69

- Predictor variables: 24 independent variables – pre-college and college experiences, college environment – were explored



Conceptual Model



Espinosa, L.L. (2008). The academic self-concept of African American and Latina(o) men and women in STEM majors. *Journal of Women and Minorities in Science and Engineering*, 14(2), 177-203



Significant Predictors for Women

Working on Group Projects in Class

- Supports student development theories on relational knowing
Belenky, Clinchy, Goldberger, and Tarule, 1986; Baxter-Magolda, 1992
- Cooperative and collaborative learning related to women's confidence in becoming an engineer Colbeck, et al., 2000
- Active learning may make the academic environment less intimidating Mau, 2003; Seymour & Hewitt, 1997
- Peer groups serve as important support structures for women of color in engineering Tate & Linn, 2005



Predictors for Women

Tutoring Another Student

- Reinforces value STEM women place on personal relationships
Cross, 2001; Heath, 1994; Seymour & Hewitt, 1997
- Has positive effects on self-concept Pascarella & Terenzini, 2005
- Predictor of aspirations to make a contribution to scientific research for URM science students
Oseguera, Hurtado, Denson, Saenz, & Cerna, 2006



Predictors for Men

Faculty Providing Research Opportunities

- Lab experiences encourage self-confidence for male STEM students
Huang & Brainard, 2001
- Creation of mentoring relationships impacts STEM persistence
Alfred, 2005; Matsui, Liu, & Caroline, 2003; Maton, Hrabowski, & Schmitt, 2000;
Seymour & Hewitt, 1997

Satisfaction with Math and Science Coursework

- Instructional quality important to male students
Huang & Brainard, 2001
- Quality instruction promotes STEM persistence
Seymour & Hewitt, 1997; Hilton, et al., 1995



2009 Dissertation Study on Women of Color in STEM

- Higher Education Research Institute Surveys
 - 2004 Freshman Survey
 - 2008 College Senior Survey
- 2 level model: individual student (level 1) & institutional characteristics (level 2)
 - Hierarchical analysis allows for the examination of those predictors that help women persist in STEM relative to their distinct college/university environment



Research Significance of Studying Women of Color in STEM

- Women of color will constitute 20% of the nation's populace 15-24 yrs. of age in 2010

U.S. Census Bureau, 2001

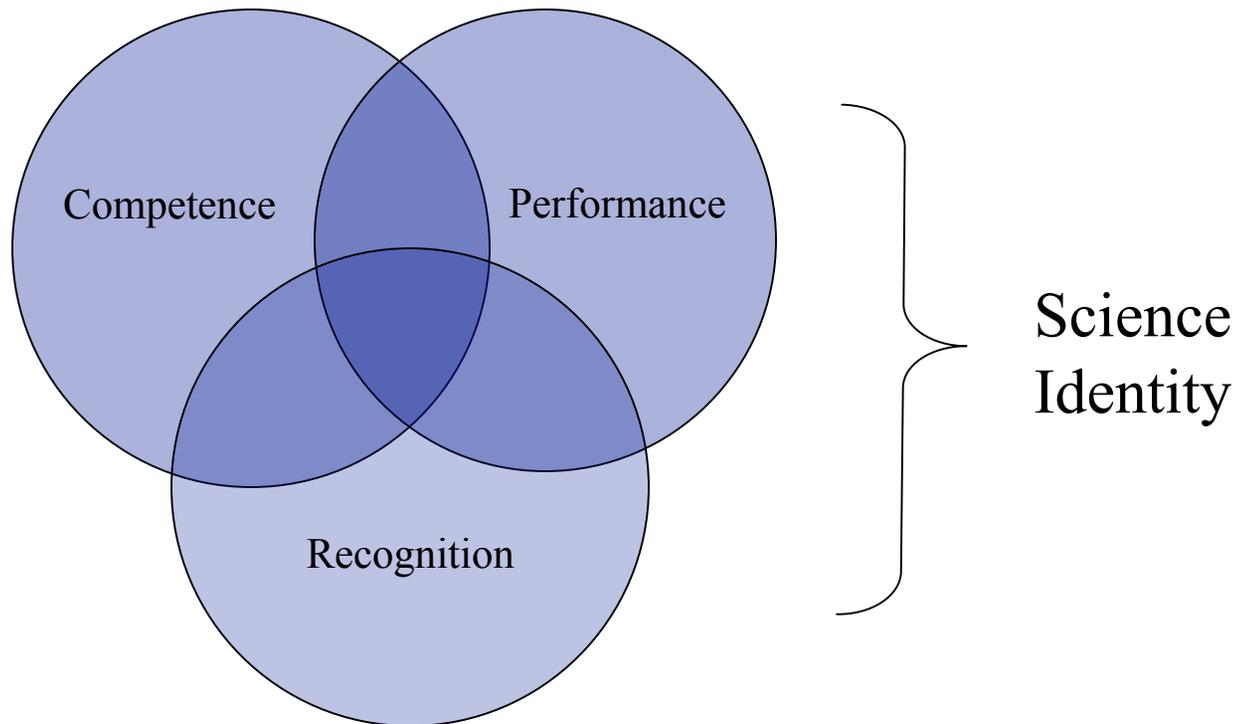
- Yet, women of color earned just 7% and 4% of the nation's bachelor's degrees in engineering and physics, respectively

National Science Foundation, 2007

- Less likely to persist in STEM past the baccalaureate into graduate study and scientific careers, even in fields where they have achieved parity (e.g. biological sciences)

National Research Council, 2006

Science Identity Model (Carlone & Johnson, 2007)



Carlone, H. B. & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, 44(8), 1187-1218.



WOC College Experience Measures

Scientific Performance & Recognition

- Women who stay in STEM have less faculty interaction than women who leave ($p < 0.05$)
- For every one-unit increase in discussing course content with peers outside of class, women are 11.8% ($p < 0.001$) more likely to persist in STEM
- Women who join a major-related club are 7.38% ($p < 0.05$) more likely to persist
- A one unit increase in satisfaction with science and math coursework results in a nearly 14% greater likelihood of STEM persistence ($p < 0.001$)
- Women who participated in a research program are 12% ($p < 0.05$) more likely to persist



WOC College Experience Measures

Engineering Majors

- Women who enter college with the intent to major in engineering are nearly 18% more likely to persist than students who aspired to other STEM majors ($p < 0.001$)
 - Women switch to other STEM disciplines instead of leaving STEM altogether
 - May relate to the academic preparation of aspiring engineers or the selectivity of engineering programs



“I had a good experience with my PIs [principal investigators]... as an undergrad, you kind of feel like on the bottom of the food chain and they kind of believe in you and say, “Yes, you can do this. I’m giving you this project to do and I know you can do it.” So it kind of builds your confidence and just them believing in you makes you feel like you can actually complete the project because you can.” – *University of New Mexico Student*

Hurtado, et al. (2008). Diversifying Science: Underrepresented Student Experiences in Structured Research Programs. *Research in Higher Education*.



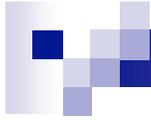
“The students are really kind of like the support network here. The students really help each other. I now if I need something and my advisor wasn’t going to give it to me, I’d definitely go to any of the students, and I know students who are ahead of me, and just talk to them about that.”

– *MIT Student*



Implications for Practice

- Establish and support mentoring relationships in multiple settings
- Collaborative classroom learning with an emphasis on small group exchange
- Opportunities for student teaching
- Academic enrichment and research programs that support men and women of color
- Tangible support of innovative pedagogical practices



Thank you!