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

- 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

- 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
**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)

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

“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!