February 2008

University of Wisconsin-Madison

THE CENTER ON
EDUCATION AND WORK

RESEARCH BRIEF

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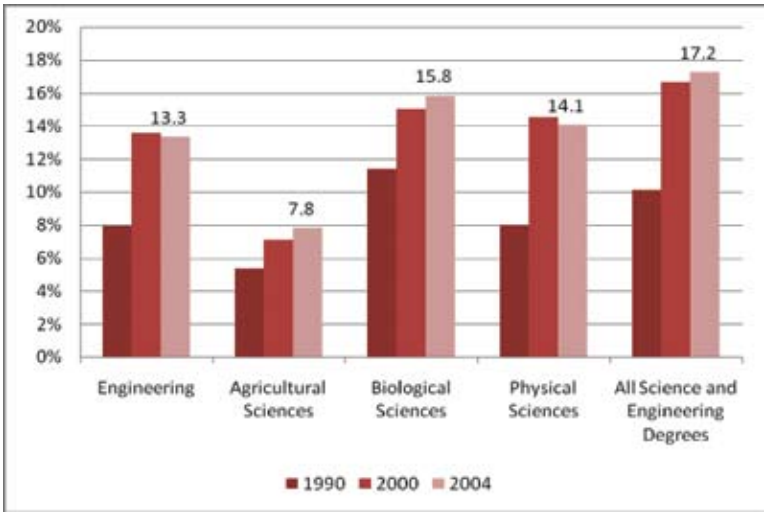
Increasing STEM Retention for Underrepresented Students: Factors That Matter

Science and engineering capability will be the foundation of economic success for the U.S. in the 21st century
—Doug Busch, Intel Vice President

Without question, U.S. competitiveness in the global economy has been eroding steadily over the last decade, as increasingly high skilled work is being done by lower-wage workers around the world. In 2004, China and India produced 500,000 and 200,000 engineers, according to Fortune magazine, while U.S. colleges graduated 70,000. Recent reports from prominent national societies and commissions have called for new policies and initiatives aimed at expanding the nation's scientific, engineering, and technical workforce. The Committee on Science, Engineering and Public Policy (2005), U.S. Innovation (2005), and others have called for new investments in higher and postsecondary education to create a significantly larger, more diverse talent pool of individuals interested in engineering and technical careers. In his recent bestseller, *The World is Flat*, Thomas Friedman described the U.S. lack of focus on preparing for the global, technology-intensive economy as the "quiet crisis."

There are multiple reasons for the comparatively low percentage of STEM (Science, Technology, Engineering and Mathematics) undergraduate degrees in the U.S., including well-documented declining student interest in these fields. Another reason is the underrepresentation of Bachelor degrees earned by targeted minority students (i.e., African Americans, Latino/as, South East Asians, and Native Americans; collectively referred to as ALANA students) in these fields. Despite steady increases over the past 15 years, ALANA students continue to be substantially less likely to complete degrees in agricultural sciences, engineering, and physical sciences, when compared to degree completion by their counterparts in all science and engineering fields.

Percent of STEM Bachelor's Degrees Awarded to U.S. Citizens from Under-Represented Populations (African American Hispanic, Native American) - 1990, 2000, 2004



Source: Commission on Professionals in Science and Technology, STEM Workforce Data Project, Data Archive Group 10. http://www.cpst.org

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Surveys of entering freshmen indicate that the intentions of ALANA students to major in a STEM field are similar to the intentions of white students. Although ALANA students' *intentions* to major in STEM fields are similar to white students, ALANA students are less likely to actually major in STEM fields and more likely to drop out once they have declared a STEM major (Astin, 1996; Morning & Fleming, 1994; Reichert, 1997 as cited in Committee on Science, Engineering, and Public Policy, 2007).

One important strategy for meeting the STEM talent development challenge is to address retention of domestic ALANA students in STEM. Federal projections indicate that ALANA groups combined will account for the largest growth in labor force participation for the next ten years (Fullerton & Toossi, 2001). Increased retention and graduation of those ALANA students pursuing STEM degrees could positively impact the nation's STEM labor force demand for qualified workers.

National graduation data for STEM majors reveal that by the sixth year of college, only about 29% of ALANA STEM students entering STEM majors graduate compared to about 40% of all students entering STEM majors.
—(Hayes, 2007)

Why So Few?

Some have suggested that ALANA students simply are not interested in pursuing degrees in STEM fields. However, a meta-analysis of studies representing over 19,000 individuals found no statistical differences across racial groups in their career interests or aspirations (Fouad & Byars-Winston, 2005). ALANA individuals, however, anticipated more career barriers whereas non-ALANA individuals anticipated more career opportunities. These findings indicate that individuals tend to have similar career goals but different expectations for realizing their goals.

Ability does not seem to be a factor either. Seymour and Hewitt (1997) found that students who leave the sciences have similar grades in STEM classes as those students who persist. More specifically, many women and underrepresented students leave STEM fields despite having good grades. Past research has shown that some reasons why ALANA students are not retained in the sciences include:

- A 'chilly climate' in their classroom experiences (Cabrera, Colbeck, & Terenzini, 2001)
- Greater barriers in degree attainment, such as lack of mentoring (Seymour & Hewitt, 1997)
- Experience of prejudice and discrimination on campus (Brown, Morning, & Watkins, 2004)

What Factors Are Important in Retaining Students in the Sciences and Engineering?

The research literature indicates that three factors are influential in the academic achievement and retention of ALANA students:

- Contextual
- Cognitive
- Cultural

Contextual factors capture how students perceive their surrounding environment, such as perceptions of campus climate, faculty support, and academic or career barriers. Cognitive factors include self-efficacy beliefs ("Can I succeed in this major?") as well as self-confidence in in performing well academically and coping with the challenges of degree completion. Cognitive factors also include outcome expectations or beliefs about the consequences of one's actions ("If I do this, what

will happen?" "Is this major worth it?"). Cultural factors encompass students' ethnic identity (personal sense of belonging, pride, and security in one's ethnic group) and other group orientation (one's comfort interacting with others different from one's own racial/ethnic group).

What Matters?

The rapidly expanding diversity among U.S. college-going students coupled with the limited interest among ALANA students in high wage college majors presents a major conundrum for education and workforce development policy makers and the higher education community. In sorting out the complex factors influencing academic achievement and retention in high demand college majors (e.g., STEM career fields), a pivotal question is: What matters most in engaging and retaining ALANA students?

Occupations in science, technology, engineering, and mathematics (STEM) are expected to grow by 22% between the years 2002 and 2012. In comparison, the job growth for all other occupations is 10%.

—U.S. Bureau of Labor Statistics, 2007

Academic retention in STEM majors is not pre-determined or readily predicted. As suggested above, retention decisions are informed by on-going, interactional processes among the individual, cultural and peer influences, social dynamics, and environmental factors. In contrast to much of the retention research, this study uses a culturally-relevant career model—the Social Cognitive Career Theory (Lent, Brown, & Hackett, 1994; 2004)—to investigate the relative contribution of outcome expectations (beliefs about the consequences of one's actions) and self-efficacy (confidence in one's ability to succeed) on student retention across ALANA groups and across STEM disciplines. Retention is defined as persistence in a STEM major and measured in two ways: (1) students' self-reported intention to remain in and earn a STEM degree and (2) actual semester-to-semester persistence data from student records. This brief summarizes the Year 1 data, which sought to predict ALANA students' STEM intentions.

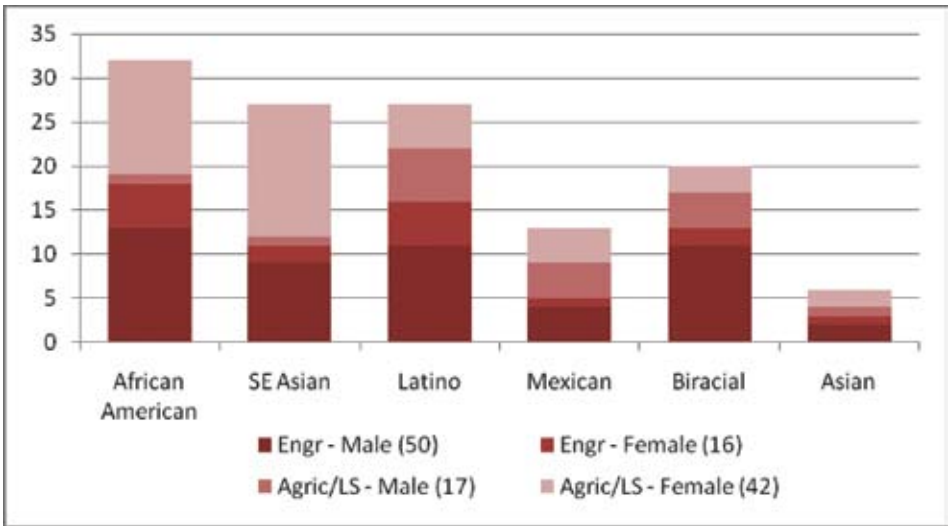
Methods

The three influential factors on retention of cognitive, contextual, and cultural variables are captured within the SCCT model. The following table describes the survey and interview measures used to assess these variables.

Study Variables	Definition
Cognitive	
Math/Science Academic Self-Efficacy	Confidence in ability to successfully complete academic milestones related to degree attainment
Math/Science Coping Self-Efficacy	Confidence in ability cope with academic challenges
Math/Science Outcome Expectations	The payoff of a STEM degree and usefulness to future employment
Math/Science Interests	Preference for/enjoyment of math/science activities and courses
Contextual	
Perceived Campus Climate	In and out of classroom experiences
Cultural	
Ethnic Identity	Ethnic group comfort and pride
Other-Group Orientation	Comfort with others outside of own ethnic group

Agricultural and Life Students were recruited from the College of Engineering (CoE) and the College of Agricultural and Life Sciences (CALS) via e-mail, telephone, and student organizations. Students completed either a 20–minute web-based survey or a paper and pencil survey.

Demographics of the Study Participants (n=128, population=333; Engineering Majors - 66, Agriculture/Life Science Majors - 59)



Regression analyses were conducted to assess the contribution of SCCT factors in predicting 1) students' STEM interest and 2) intention to graduate with a STEM degree. It was hypothesized that students' STEM interest would be predicted by their outcome expectations and self-efficacy beliefs. Additionally, it was hypothesized that students' intent to graduate with a STEM degree would be predicted by self-efficacy, outcome expectations, and STEM interest. Correlational analyses were conducted to assess contextual and cultural factors.

Factors That Matter

1. *Predicting STEM Interest:*

- STEM interest was predicted by students' positive outcome expectations about a STEM degree and related employment
- Academic self-efficacy was predictive of STEM interest as well

Students who believed that a STEM major was worth the effort and believed that they had the ability to complete their degree were more likely to be interested in a STEM major.

2. *Predicting Students' Intention to Graduate with STEM Degree:*

- Positive outcome expectations about the payoffs of a STEM degree and its usefulness to future employment were predictive of intent to graduate with a STEM degree
- Academic self-efficacy also predicted intent to graduate with a STEM degree

In this analysis, it is important to note that outcome expectations were equal to or greater than the influence of academic self-efficacy in explaining participants' STEM interests and STEM intentions.

3. *Contextual Factors*

In interviews, students perceived their environment at the UW-Madison as follows:

- ALANA students felt safe and comfortable in classes and in lab.
- ALANA students perceived a general attitude of prejudice on campus that

included experiences with racism and hearing negative comments about their ethnicity, particularly from academic staff.

Although students may not always experience overt negative experiences in the classroom/lab, the same is not true outside of these settings including department offices and other areas on campus.

4. *Cognitive Factors*

In measuring how confident students felt about being successful in their major and degree attainment:

- Students were more confident about succeeding in their major in the short term (next semester), but progressively less confident about succeeding in the long term.

In assessing how confident students felt about their ability to cope with various barriers to degree attainment:

- Students reported feeling least able to cope with lack of support from professors or advisors
- They also reported being concerned about balancing personal and academic aspects of their lives
- Students' overall belief in their ability to cope with different problems was positively correlated with positive perceptions of campus climate (see number 3), their confidence in degree attainment (see number 4), and generally positive attitudes about the "payoff" of their degree and subsequent employment

5. *Cultural Factors*

Although Ethnic Identity was not strongly correlated with other variables, ALANA students' "Other-Group Orientation" was positively related to their:

- Academic self-efficacy
- Coping self-efficacy
- Outcome expectations
- Perceptions of campus climate

Students who reported feeling comfortable with people different from themselves were more likely to feel academically confident, able to cope, posses positive expectations, and perceived a more positive campus climate.

How Can Faculty and Staff Increase STEM Retention by ALANA Students?

- Strengthen and/or help maintain students' confidence in their academic ability
- Address any student's decline in academic self-efficacy promptly; examine perceptions of academic competition among peers
- Address students' beliefs about their *academic* and *career expectations*
- Explore factors that inform students' commitment to STEM careers
- Acknowledge and affirm students' experiences with and negotiation of themselves as *cultural beings*
- Attend to students' bicultural competence and coping skills
- Address students' perceptions of hostile campus climate
- Assess campus climate at departmental levels, especially with staff

Retention efforts are well poised to create empirically driven interventions. The Sloan Project offers one model for using rigorous research to provide clear directions for culturally relevant factors to focus on in retention efforts.

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Supported by the Alfred P. Sloan Foundation, a research team led by Dr. Angela Byars-Winston at the University of Wisconsin-Madison is investigating factors that contribute to ALANA student retention in the sciences and engineering. Launched in 2005, the Sloan Project for Diversity in STEM Retention is a three year study dedicated to the longitudinal examination of ALANA undergraduate STEM retention. The Sloan Project is administered through the UW Center on Education and Work and operates in collaboration with the College of Agricultural and Life Sciences and the College of Engineering.
Project #133 HJ59, 2005-2008. Sloan Foundation Project Officer: Dr. Ted Greenwood.

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