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Information Sheet:
Retention of Underrepresented College Students in STEM

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Dena is a 20 year old Hispanic female finishing her second year of a bachelor's degree in chemical engineering at a large flagship institution. The college of engineering (COE) at the university was very interested in attracting more female and ethnic minority students like Dena. Although she had been an excellent student in math and chemistry in high school, Dena still was not sure what professional direction she wanted to take. However, the COE's offerings were tempting and she had always been somewhat interested in engineering. So, after her first year in college, Dena had applied for and was accepted into the chemical engineering program.

It was now March and the academic year was not going well. Dena never really made any friends in the program and she felt like an outsider at most department gatherings. Unlike in high school, faculty seemed distant and did not appear to be invested in whether or not students learned. Classes were dry and boring, although certain students, mostly male, appeared to be excited by and thrived in the classes. These students seemed to be rewarded for such enthusiasm and spoke of projects with they were working with faculty, while Dena had received no such invitations. She hardly managed to persuade other students to work with her in lab. Further, she had taken on more hours at work to fund a summer research program, which left little time for study. Dena's grades at the end of first semester were borderline poor and she had little hope that her second semester grades would be much better. Making plans for the next academic year, Dena was seriously thinking about leaving the COE to pursue a degree in a different discipline.

Some retention models (e.g., Bean & Eaton, 2000; Tinto, 1988) fail to consider the role that culture may play in the retention of minority students, particularly those attending predominantly White institutions (PWIs). In response, Rodgers and Summers (2008) proposed that, due to unique cultural experiences, the retention process (or those things deemed to be important for retention) likely looks different for minority student populations.

In a discussion of retention of women and ethnic minorities in engineering and other science, technology, engineering, and math (STEM) fields, it is necessary to understand and treat women's involvement in generally masculinized fields, as a specific example of a population attempting to operate in an academic environment in which they are the minority. As suggested by Rodgers and Summers (2008), we must question our assumptions regarding the elements deemed necessary for success and retention of students in academic programs and general academic spaces where they are the minority due to race, ethnicity, or gender. Here, the focus will be to consider retention within a psychological framework. That is, how do things like students' expectancy for success (self-efficacy), motivation, and attitudes affect women and minority students' satisfaction, success, and retention in their STEM programs?

Self-Efficacy

The findings of Besterfield-Sacre, Moreno, Shuman, and Atman (2001) and Arnette (2004) suggests that simple preparation in math and science fields is insufficient for the positive mastery experience that is

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important for the completion of degrees in STEM fields. Instead, the authors propose that social support systems from family, faculty, or other students are a more crucial element in how women and minority students perceive their chances of completing their STEM degrees (Aluede, Imahe, & Imahe, 2002; Bradburn, 1995). Racial and ethnic microaggressions (smaller occurrences of prejudice that may go unnoticed by the perpetrator) create barriers between students and faculty that can hinder students' willingness to seek support or help in the face of academic trouble or concerns (Solarzano, Ceja, & Yosso, 2000; Zeldin and Pajares, 2000).

Motivation

Students' motivation to engage in a task, such as pursuing a degree in STEM, is the result of the interaction between the value they place on the task and their expectancy for succeeding (Eccles et al., 1983). The value placed on a task is the result of students' assessment of the cost involved, their interest in the task, the usefulness of completing the task, and the value placed on completing the task. Of the components of task value, cost is of particular interest in thinking about why women and ethnic minorities choose to stay or leave STEM studies. These students may perceive costs such as loss of "womanhood" or ethnic identity as they are often expected to operate in the "white man's world" of STEM (Furr & Elling, 2002; Gneezy, Niederle, & Rustichini, 2003).

Attitudes

Bean and Eaton (2000) proposed that students' attitudes were the result of a reciprocal commitment: institutional commitment (to the student) and students' feelings of commitment to the institution. Institutions demonstrate their commitment to students via visible faculty and academic support, and by demonstrating a respect for those things that students of particular ethnic or gender groups find important. Reciprocally, students' commitment to the institution can be the result of perceptions of campus climate and feelings of belongingness. Interactions with faculty, other students, as well as university and department efforts to recognize and respect the contributions of women and minorities in STEM all contribute to positive evaluations of the climate of the program (Hanson, 2004; Johnson, 2007). Likewise, students' feelings of belongingness and commitment to the completion of their STEM programs are also influenced by the special efforts that departments do or do not make to ensure that underrepresented students are a part of the fabric of the program (Chinn, 1999; Cronin & Roger, 1999).

Impact on Individual Performance

The motivator that drives most students' progress in a degree program is grades. However, there are many contextual factors that set the stage for students' academic success, such as students' pre-college or pre-graduate school preparation, their beliefs in their ability to complete their degrees, their level of comfort with faculty and other students, the availability of academic resources, the congruence that exists between the culture of the department and that of students' individual ethnicity, and previous academic cultures. All of these things, when combined, have the potential to strongly influence students' academic success and their subsequent retention.

In the case of Dena described above, she appears to have the appropriate academic background, having excelled in math and science in high school and scoring well on college entrance exams. Yet, by the end of the school year, she is performing poorly academically and appears to be generally disengaged from the program. How did she get to that point? As a Hispanic female in a degree program dominated by White males, Dena was likely in the minority in her classes and in other more social situations. The teaching style of faculty also appeared incompatible with how she was used to learning. It was detached and a small group of male students were allowed to dominate the academic space. If she perceived women, especially Hispanic women, were not truly welcome in the department, as Dena fell farther and farther behind in her classes, she may have become less likely to seek academic help for fear of confirming the negative stereotype of women in STEM held by some faculty and male students.

Focus on Application

Per the research on women and underrepresented students in STEM, there are several actions the college of engineering could have taken to make Dena's experiences more positive and increased the likelihood that she would complete the degree she started:

1. Put students in contact with a faculty mentor. This mentor would ideally be female or an ethnic minority, but male faculty mentors can be successful too (Ensher et al., 2006; Ragins, 1997; Tenenbaum, Crosby, & Gliner, 2001). Due to small numbers of females and minority mentors in STEM, special efforts should be made to forge connections between students and faculty.
2. Provide academic resources (e.g., study sessions, team assignments, group study, peer or faculty tutoring), preferably throughout the semester, and definitely if students are having academic problems at any point in the semester.
3. Make a special effort to bring together female students and/or those of similar backgrounds. A portion of Dena's dissatisfaction with her program was due to feelings of being left out without having a social support system that could identify with some of her concerns.
4. Urge faculty to scrutinize their classroom practices and student interactions to ensure gender-neutral structure and student involvement. Possibly, the style of Dena's courses were geared more towards a competitive, hands-off approach, as compared to a more personal and collaborative approach.. Faculty should be sensitive to the fact that students learn in different ways and as STEM classrooms begin to contain more women and minorities, pedagogical and interaction patterns need to be sensitive to the presence of these students (McKenna & Bugrahan, 2007). A research overview by the Assessment of Women in Engineering project suggests that cooperative learning approaches, for example, while beneficial for all students, may be especially effective for women and students from underrepresented ethnic groups (AWE, 2005). Pedagogical literature supports the use of additional teaching methodologies and documents the success and benefits of these methods over traditional lecture courses (see Jones, 2007; Cooper & Robinson, 2000; Saville, Zinn, Neef, Van Norman & Ferreri, 2006
5. Investigate additional financial resources to support students. This may be especially important in STEM, where the academic rigor is high and is not always conducive to maintaining outside employment (Perna, Lundy-Wagner, Drezner, Gasman, Yoon, et al., 2007).

Recommendations for Action/Future Research

As we continue to encourage women and students from minority backgrounds to seek careers in STEM disciplines, we also need to continuously evolve our methods of examining their experiences and successes in order to meet the needs of this growing, but still small, population in STEM. Specifically, further research should seek to answer the following questions:

- Why is the retention of underrepresented STEM students attending historically Black colleges and universities (HBCUs) and other minority serving institutions (e. g. Hispanic-serving institutions) higher than predominantly White institutions? How do admissions standards, pedagogy, and climate differ? How can PWIs simulate these climate differences?
- What effects do different pedagogical practices/approaches have on persistence in STEM disciplines? How might STEM pedagogy be adjusted so that it becomes more gender-neutral?

- When women and minorities leave STEM, do they leave school altogether or switch to another discipline? What guides these decisions?
- How effective is inclusiveness training for STEM faculty?
- What makes STEM disciplines such as biology more successful at attracting and retaining women of varying cultural backgrounds than physical sciences and engineering?
- What part does social encouragement from family, faculty, friends, and significant others play in the persistence of women in general and women from underrepresented ethnic backgrounds in attaining degrees in STEM fields?

Through these and other investigations, we can continue the ever-evolving process of understanding what guides, excites, and retains women and ethnic minorities in STEM disciplines.

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