



Information Sheet: Increasing Diversity in STEM by Attracting Community College Women of Color



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Introduction

Attracting more women of color to science, technology, engineering, and mathematics (STEM) from students attending community colleges is a practical and expeditious route to diversifying STEM. To attract women of color, a focused effort at recruitment and retention, informed by an understanding of the challenges and obstacles, is required; however, little research has explored the experiences of women-of-color STEM students while enrolled in community colleges or after they transfer to a university. This review presents research about STEM experiences in higher education for women, students of color, and transfer students, affirming the need for more research on women of color at community colleges for diversifying the U.S. STEM workforce.

Community colleges historically have been an important corridor for women and students of color entering higher education. In 2003–04, 59% of students attending community colleges were women and more than 35% were students of color (Provasnik & Planty, 2008). Although an estimated two-thirds of community college students intend to transfer to four-year institutions, low transfer rates have been discussed often (Bradburn, Hurst, & Peng, 2001; Gross & Goldhaber, 2009; Roksa & Calcagno, 2008). Transfer rate estimates range from 25% to 52% (Hoachlander, Sikora, Horn, & Carroll, 2003; The University of Arizona Fact Book 2001–02, 2001) because of varying definitions of “transfer students” (e.g., with or without Associate degrees, etc.). Low transfer rates might not support STEM recruitment at community colleges, and a National Action Council for Minorities in Engineering Inc. report (Rivera, 2010) suggests that strengthened collaborative efforts between two- and four-year institutions, including programs designed for transfers, would result in higher retention and completion rates in STEM for students beginning at community colleges than students beginning at a four-year university.

Complicated data collection priorities, such as using six-year windows to assess persistence rates (Chen & Weko, 2009), counting students who do not complete two-year degrees before transferring as dropouts (Bailey et al., 2004), and no disaggregation of data (Bailey, Jenkins, & Leinbach, 2005), have made it difficult to draw an accurate picture of how community college attendance affects overall STEM graduation numbers. The National Science Foundation reported that on average 44% of science and engineering students have at some point attended community colleges, with even higher percentages reported for Hispanics, American Indians/Alaskan Natives, and Blacks (Tsapogas, 2004). Certainly the potential is great for increasing the flow of underrepresented students, particularly women of color, from community colleges into STEM.

Background

In 2005 the National Academies established the Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology to investigate what federal policy makers could do to enhance the science and technology enterprise. The guiding principle for the committee was that the United States successfully compete, prosper, and be secure in the global community of the 21st century. The resulting report, *Rising above the Gathering Storm: Energizing and Employing America for a*

Brighter Economic Future (National Academy of Sciences, 2007), contained the findings and recommendations of the committee and identified two key challenges: creating high-quality jobs for U.S. citizens and responding to the nation's need for clean, affordable, and reliable energy. The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (Competes) Act (Pub. L. No. 110-69), the associated authorization bill, was signed into law in 2007. One of President Obama's first official actions was signing the American Recovery & Reinvestment Act (also referred to as the "stimulus bill"; Stine, 2008), which contained appropriations for the Competes Act. Budgetary increases to the federal agencies responsible for funding education, research, and development were aimed at addressing the *Rising above the Gathering Storm* recommendations.

As is often the case in government reports and recommendations, an explicit focus on diversity (i.e., gender, race/ethnic, and ability) among teachers, in the U.S. science and engineering talent pool, in programming, and in geographic distribution was missing. Direction on how to approach the limited access to STEM preparatory courses (advanced placement or even adequate math and science programs) and resources in underserved schools also was not addressed. Further, reference to the vast literature on intervention programs targeting underrepresented groups to increase recruitment, retention, and transition was noticeably absent (National Academy of Sciences, 2007).

Clearly articulated in *Rising above the Gathering Storm* was the demand for U.S. universities to produce engineers and scientists faster than the retirement rate of U.S. engineers and scientists. The United States has overrelied on international students in the past, but international students are increasingly opting to return to their own nations (especially in computer science and engineering fields), where the strategy of "coupling education-abroad programs with strategic investments in the science and engineering infrastructure—in essence sending students away to gain skills and providing jobs to draw them back" has been growing (National Academy of Sciences, 2007, p. 82). Population trends in the United States, where women currently make up 51% of the population (U.S. Census Bureau, 2010) and non-Hispanic whites are projected to become the minority (47% of the total population) by 2050 (Passel & Cohn, 2008), mean that potential future engineers must be recruited from the increasing proportions of women and underrepresented groups.

Rationale for Diversifying the STEM Talent Pool

Nelson and Brammer (2007) argue that the United States needs to shift away from the old patterns of importing international students and recruit U.S. students into STEM. While international scientists and engineers might address the critical need to replace retiring U.S. STEM professionals, Nelson and Brammer say that international students will "not fulfill the need for scientists and engineers who will transfer U.S. values, culture, and interests while developing solutions critical to national, international and global crises" (p. 3).

Women, who make up 51% of the U.S. population (U.S. Census Bureau, 2010) and are attending higher education institutions in record numbers, present a ready group of recruits from which to increase the number of U.S.-born engineers and scientists. A focus on recruiting and training women of color also would diversify the U.S. STEM pool. The motivation to transfer U.S. values, culture, and interests into solutions is embedded in the expressed desires of women and other underrepresented individuals to work on projects that are environmentally and socially conscious and benefit their own communities (Aronson, Reyes, & Goldberg, 2003; Seymour & Hewitt, 1997), and many individuals in underrepresented groups leave STEM because they believe that the fields have no social relevance (Bonous-Hammarth, 2000; Carter & Hurtado, 2007).

Increasing and diversifying the U.S.-born STEM pool will improve the U.S. competitive presence on the global stage, but learning to interact and collaborate with multicultural people internationally is also critical for assuring the place of the United States in the global economy. Researchers find that the education of all students is enhanced by interactions with diverse populations, and those experienced in diverse situations are better prepared to work with multicultural populations on the global stage (Bonous-Hammarth, 2000; Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2008; Spinosa, Sharkness, Pryor, & Liu, 2008). An increased participation of historically underrepresented students in STEM fields promises to bring multicultural experiences as well as new concerns, needs, and motivations for innovation in the United States and globally.

Demographics of Community College Populations

Characteristics of community college students affect their decisions about the pursuit of and persistence in higher education. On average, community college populations are more likely to be older, women, ethnically diverse, working off campus, and occupying lower income brackets than the undergraduates at four-year universities (for details see Table 1). These factors have been correlated with low participation and varied success in higher education (Joshi, Beck, & Nsiah, 2009; Laanan, 2003; Warburton, Bugarin, Nuñez, & Carroll, 2001) and STEM specifically. The relationship of characteristics to pursuit or persistence will be discussed in more depth below. Community colleges are well suited to address many of the needs of their diverse student populations by providing affordable tuition, part-time and flexible scheduling, small class sizes, access to faculty, and child care.

Articulation policies in STEM (agreements between colleges and universities to accept transfer credits) are in place in a number of states, but transfer students often discover that some courses do not transfer (Rivera, 2010). Poor advising can result in overloading core courses in the first semester following the transfer (Reyes, in press). Transfer students are caught unaware by the transition to classes of 100 to 300 students, faster-paced coverage of material, little to no access to faculty, timed tests, and grading on a curve (Chang, 2006; Laanan, Jackson, & Darrow, 2010; Reyes, in press; Y. Valenzuela, 2006). When students' grades drop in the first semester after the transfer (called "transfer shock"; Carlan & Byxbe, 2000; Hills, 1965), an "A" student from a community college might quickly become a "C" student at a university. Adding to these challenges are the feelings of not belonging due to being the only woman or woman of color, an older student, or a transfer student. The transfer process for many community college students has been grueling and has negatively affected persistence and retention (Ornelas & Solorzano, 2004).

Table 1 compares characteristics of students at community colleges and four-year universities, both public and private not-for-profit. The median age of community college students was 24 years, with 35% of students 30 years old or older (Provasnik & Planty, 2008). Women were enrolled at public higher education institutions in greater numbers (54%) than males (46%) according to Provasnik & Planty (2008). The National Science Foundation (2009) reported that 59% of those attending community colleges were women, and more than 35% of the community college population were students of color, with women of color making up the largest proportion (21%) of the total. Twenty six percent of students at community colleges were in poverty brackets (Provasnik & Planty, 2008). In 2004, the largest percentage of Black, Hispanic, and Asian students (gender breakdowns not available) in community colleges were low-income students and single parents working outside the home while attending school part time (Horn & Nevill, 2006).

Table 1. Comparison of Student Characteristics in Community Colleges and Four-Year Institutions

Community Colleges	Four-Year Institutions	References
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		Public	Private not-for-profit		
Gender composition					
	Female	59.1%	54.5%	55.9%	P&P *
	Male	40.9%	45.5%	44.2%	P&P
Ethnicity					
	White	59.9%	70.2%	67.3%	P&P
	Black	15.3%	10.3%	13.0%	P&P
	Hispanic	14.4%	8.9%	12.0%	P&P
	Asian	5.3%	5.9%	4.2%	P&P
	American India/Alaska Native	1.0%	1.0%	0.4%	P&P
	Pacific Islander	0.7%	0.4%	0.2%	P&P
	More than one ethnicity	2.1%	2.0%	1.8%	P&P
	Other	1.3%	1.2%	1.1%	P&P
Median age					
		24	21		P&P
Parent w/college degree					
		32.1%	50.4%	52.2%	P&P
Lowest income (percent of poverty level)					
		26.4%	20.3%	20.3%	H&N *
Working off campus					
	Full-time	41.0%	23.0%		H&N
Marital status					
	Not married	70.4%	85.1%	81.8%	H&N
	Married no children	15.8%	17.7%		H&N
	Married w/children	32.6%	27.4%		H&N
	Single parents	25.1%	18.0%	9.0%	H&N

* P&P refers to Provasnik & Planty, 2008; H&N refers to Horn & Nevill, 2006

Chang (2006) and Y. Valenzuela (2006) used qualitative methods to highlight additional characteristics for women of color at two-year colleges and followed these women throughout the transition to universities. Valenzuela found that most self-identified Chicana/Latinas transferring into STEM fields at two California universities were the first in their families to pursue college degrees, balanced extraordinary family responsibilities, and experienced contradictory messages about educational expectations. At the same time, the women drew inner strength (“fuerza”) from the cultural capital of their families and communities.

Challenges of Recruiting Women of Color to Transfer into STEM at Universities

Many programs (such as outreach, bridge, intervention) responsible for the increase in the number of underrepresented students entering STEM fields have focused on students starting at four-year institutions rather than targeting students from community colleges (DePass & Chubin, 2009; Knight & Cunningham, 2004). Historically black colleges and universities, tribal colleges and universities, and Hispanic-serving institutions are responsible for much of the increase of underrepresented students, albeit small in overall

numbers, in STEM fields (DeVoe, Darling-Churchill, & Snyder, 2008; Dowd, Malcom, & Bensimon, 2009; Dowd, Malcom, & Macias, 2010; Solorzano, 1995). Recruitment, remediation, and preparation through community colleges have been suggested to diversify the STEM talent pool (Chapa & De la Rosa, 2006; Chubin, DePass, & Blockus, 2010; Dowd et al., 2010; Hudis, 2009; Mattis & Sislin, 2005; Rivera, 2010).

Among the obstacles to recruiting women of color at community colleges into STEM may be a limited understanding among the general population of what scientists and engineers do, in part due to “poor-quality education and limited opportunities to learn about the science and health world” (Zambrana, 1996, p. 150). This limited understanding is the subject of the National Academy of Engineering report *Changing the Conversation: Messages for Improving Public Understanding of Engineering* (2008). Adults and teens (both non-White and White) surveyed regarding professions were less familiar with engineers and scientists than other professions. Least familiar (or least understood) for all teens surveyed were engineers (sometimes tied with scientists). Of all survey participants, Hispanic and African American girls had the lowest familiarity with engineers. Questions to teens about engineers they knew resulted in names of male engineers only. Perceptions of STEM professionals as “male and pale” may lead to thinking such as “I’m a Latina, I just don’t belong” (Margolis & Fisher, 2002; Varma, 2002, 2006).

White women and women of color have expressed a desire to do socially relevant work that would benefit their own community (Cole & Espinoza, 2008; Grandy, 1998; Seymour & Hewitt, 1997) and considered engineering a mismatch. Instead they chose biology- or medicine-related fields and dismissed engineering due to a limited understanding of how they could serve the community with an engineering degree. In the *Changing the Conversation* study, Hispanic girls were less likely “to believe that engineering has a positive effect on peoples’ daily lives” (National Academy of Engineering, 2008, p. 94).

In addition to a limited understanding about how STEM careers can be socially relevant, students at low-resourced schools receive limited or no access to advanced placement courses necessary for preparing students to participate in STEM fields in higher education. This is especially pronounced in poor, underserved communities, creating challenges for community colleges, the gateway for many students of color to higher education (Solorzano & Ornelas, 2002, 2004). Community colleges report that six in ten students take at least one remedial course and approximately two-thirds or more of community college students enter with weak academic skills (Bailey, 2009). Some women of color reported that they were advised away from college prep courses that led to STEM fields and toward vocational paths (Reyes, in press) or received little encouragement for higher education, referred to as “tracking” (Auerbach, 2004; Nieto, 2000; Reyes, in press; Solorzano & Ornelas, 2004; A. Valenzuela, 1999; Varma, 2002; Zambrana, 1996; Zambrana & Zoppi, 2002).

Women who reported negative early experiences or no encouragement to pursue STEM were surprised at how capable and inspired they were once they had a positive learning experience at community college (Starobin & Laanan, 2008). Chang (2006, p. 62) noted that student-of-color transfers into STEM described “community college classrooms as breeding grounds for interest in the sciences and their university lecture halls as weeding grounds to relieve impacted majors.” Similarly Wolf-Wendel, Twombly, Morphew, and Sopcich (2004) talked about nontraditional-aged Latinas and African American women who perceived “being given a second chance to develop their potential” and their talents being fostered by faculty and advisers at community college. Women-of-color transfers in the Chang study (2006) credited the teaching style of a mathematics faculty member at the community college who made himself and the course material approachable, in contrast to their early academic experiences.

Role models, family members, mentors, and institutional resources that help students navigate higher education and provide opportunities that contribute to the professional development of students in STEM are considered social capital (Yosso, 2005). Recruitment activities among women of color that included family and community, were culturally appropriate, and enhanced social capital were the most effective. Auerbach (2004) reported on Futures and Families, an innovative college-outreach program that incorporated the pivotal role of Latino parents and provided workshops for Latino families on preparing for college and advocating for their children to attend higher education. The result enhanced the social capital of the participating Latino families and created “critical capital” that led most students (males and females) from participating families to enroll in a university.

For women of color it is important to acknowledge that they often do not fit the “typical” student profile. In addition to having few higher education or STEM mentors, they may be atypical in other ways, perhaps having children or being older returning students, transfer students, returning military, or handicapped students. Futurebound, a three-year recruitment and retention program funded by the National Science Foundation (HRD-0120878), recruited women (with a focus on women of color) at Pima Community College to transfer into STEM fields at the University of Arizona (Reyes, in press). Futurebound women who participated in an optional transfer course received advising on course selection, financial aid, and parking restrictions and reported that the anxiety of transfer expressed by many transfers elsewhere (Ornelas & Solorzano, 2004; Townsend, 2008; Townsend & Wilson, 2006) was greatly reduced (Reyes, in press). This finding has been echoed in other studies (Berger & Malaney, 2003; Hagedorn & Cepeda, 2004; Starobin & Laanan, 2008; Wassmer, Moore, & Shulock, 2004; Wolf-Wendel et al., 2004). Financially supported bridge and undergraduate research opportunities for students of color have been deciding factors in decisions to transfer into STEM at universities (Crisp, Nora, & Taggart, 2009). The National Action Council for Minorities in Engineering has listed access to financial aid as one of top factors related to retention of minority engineering students (Rivera, 2010). Women of color transferring to the University of Arizona perceived that paid undergraduate research opportunities would ease transition, facilitate integration, and lessen financial concerns (Reyes, in press).

Recruitment strategies to increase numbers of women of color transferring into STEM from community colleges are focused on long-term strategies and only half the answer; a focus on retention is also critical.

Challenges for Retaining Women of Color after Transferring to a University

Retention programs for women of color after they have been successfully recruited for transfer into STEM at the university level are the logical next step to diversifying STEM fields. These programs have been designed to meet the challenges that students face once they arrive at a university, including academic support, mentoring, undergraduate research experience, financial assistance, and community building, both on campus and off. Especially important for underrepresented communities are efforts that integrate parents and family networks (Auerbach, 2004; Hurtado, Carter, & Spuler, 1996; Hurtado, Han, et al., 2007).

Perceptions of racism and sexism have led students of color to consider switching out of science disciplines or leaving school altogether (Goodman, et al., 2002; Russell & Atwater, 2005; Sands, 1993; Solorzano, Ceja, & Yosso, 2000; Varma, 2006). Hurtado, Carter, and Spuler (1996) found that a perceived racist environment negatively affected the integration of students of color at universities. Efforts to ameliorate these experiences are crucial for students of color to succeed in higher education (Arbona & Nora, 2007; Heller & Martin, 1994; Reyes, in press; Tate & Linn, 2005; Wawrzynski & Sedlacek, 2003), such as mentoring, professional or student affinity-group involvement or providing a sounding board and safe space or “counter-space” for gatherings, academic support, and discussion of strategies for dealing with

experiences of perceived racist, sexist or other discriminatory experiences on campus (Solorzano, Ceja, et al., 2000).

Yet for other students of color, racist or sexist experiences provide the motivation and impetus to prove themselves capable of succeeding in higher education (Sands, 1993). Jennie R. Patrick, a chemical engineer, described her academic experiences as a world sometimes “filled with hate, abuse, unfairness, and discrimination,” where she “made a commitment to succeed” (Warren, 1999, p. 220). Ornelas and Solorzano (2004, p. 238) reported that despite barriers to success, “a strong sense ‘to prove them (society) wrong’” motivated “a sense of responsibility to become role models to their younger sibling or their children, and a commitment to succeed” from Latina and Latino transfer students in California.

Researchers have documented unique challenges faced by women of color in STEM and universities due to discrimination as a result of living at the intersection of gender and ethnicity (Ong, 2005; Seymour & Hewitt, 1997), described as the “double-bind” by Malcom, Hall, and Brown (1976). Common challenges include isolation, invisibility, discrimination, not belonging, and disconnects from external social and cultural networks. These alienating factors have been discussed as negatively affecting the retention of women and students of color in STEM (Hurtado, Cabrera, et al., 2008; Hurtado, Maestas, et al., 1998; Joseph, 2007; Seymour & Hewitt, 1997).

Interviews with community college women transferring into STEM fields at the University of Arizona through the Futurebound program revealed an atmosphere in which the women experienced attitudes and treatment signaling that they did not belong because of age, ethnicity, gender, or preconceptions that transfer students were not high-quality students (Reyes, in press), as discussed in other studies about transfer students that were unfortunately not disaggregated by ethnicity and gender (Berger & Malaney, 2003; Laanan, 1996). Similarly, Hurtado, Carter, and Spuler (1996) found that Latino students felt that they were treated as inferior. These attitudes are at times openly expressed by faculty and students and at other times indirectly by exclusion from activities such as study groups (Reyes, in press; Y. Valenzuela, 2006).

Sometimes a woman of color will hear conflicting messages about the family’s support for her education while being expected to simultaneously continue in her roles as caretaker and contributor to the family (Reyes, in press; Y. Valenzuela, 2006). Women of color often reported differential impacts due to gendered cultural expectations concerning family and community responsibilities (Ginorio & Huston, 2001; Sy, 2006; Sy & Romero, 2008; Tate & Linn, 2005; Varma & Galindo-Sanchez, 2006). Women-of-color transfers to the University of Arizona STEM disciplines discussed the pressures of responsibilities to their families (Reyes, in press). Futurebound transfer students with dependent children expressed varying levels of guilt about how much time they spent away from the children to prepare for classes, an experience shared by other parent-students interviewed by Tate & Linn (2005) and Varma (2002). Other University of Arizona transfer students felt intense pressure of having to succeed because of sacrificing time away from family for course work or travel to campus, as described by Sy and Romero (2008) and Varma and Galindo-Sanchez (2006).

Hurtado, Eagan, and colleagues (2007) found that for students of color, management of family and community responsibilities and relationships were critical for student academic adjustment. That is, family and community support had positive impacts on student persistence (Hurtado, Han, et al., 2007; Ornelas & Solorzano, 2004), but the pressures from responsibilities and expectations could also negatively affect adjustment. Often referred to as “pull factors” (Arbona & Nora, 2007; Nora, Cabrera, Hagedorn, & Pascarella, 1996; Varma, 2006; Varma & Galindo-Sanchez, 2006), cultural expectations and responsibilities can pull students of color away from studies to care for family members or work off campus to help with financial needs of the family (Hurtado, Carter, et al., 1996; Tate & Linn, 2005; Varma &

Galindo-Sanchez, 2006). Nora et al. (1996) found that of Hispanic and African American women interviewed, those who cared for family members were 83% more likely to leave college than were students without such responsibilities. Native American women faced unique challenges because they were forced to plan “in advance how you will handle your family matters and community events” when “the family is always calling [you] back for ceremonies” (Varma & Galindo-Sanchez, 2006, p. 4).

Women of color with families disproportionately represented in the lower socioeconomic strata often face overwhelming financial concerns related to wage disparities and caring for family members such as children, siblings, or aging parents. According to an Institute of Higher Education Policy report (Cunningham & Santiago, 2008), Asian and Hispanic students were less likely to take on major debt than were other students for fear of adding to family financial responsibilities. These students more often chose to attend school part time while working off campus to meet financial needs or “stop out” (temporarily drop out; Fry, 2002).

Often women of color (and men of color) are first-generation college students, which means that the family is probably unfamiliar with the application to college, financial assistance, and the university environment (Ojeda & Flores, 2008). As a consequence of being the first in the family to attend college or enter STEM fields, a lack of mentors or role models may limit knowledge of the multiple careers or pathways associated with STEM degrees (Rivera, Blumberg, Chen, Ponterotto, & Flores, 2007). For example, although Latina mothers have been reported as very influential in their daughters’ decisions to seek higher education and career aspirations (Flores & O’Brien, 2002; Gandara, 1995), mentors and other role models have been shown to be more important for seeking higher education in fields that have been traditionally considered male-dominated, such as STEM fields (Flores & Obasi, 2005; Rivera et al., 2007).

Finally, attending school at a campus location away from family, community, and cultural connections can be especially difficult for women from some ethnic or cultural groups, and they may choose to attend a less selective school close to family despite the consequences. Fry (2004) found that choosing a less selective school was correlated to failure to complete a degree; however, for these women a move to a more selective school would create a divide from social networks and social capital critical for student persistence (Flores & O’Brien, 2002; Reyes, in press).

Conclusion

Women of color at community colleges constitute an important resource and pool of talent that should be tapped in answer to the nation’s expressed need for strengthening (National Academy of Sciences, 2007) and diversifying the STEM workforce (Nelson & Brammer, 2007). To increase the number of women of color entering STEM career pathways from community colleges, the unique challenges and experiences of women of color in higher education must be understood. Most studies on students of color in STEM and transfers into STEM fields have not disaggregated the data by gender and ethnicity (Chang, 2006; Hurtado, Cabrera, et al., 2008; Hurtado, Eagan, et al., 2007; Hurtado, Han, et al., 2007) but highlight areas of concern in planning for the success of students of color potentially transferring into STEM.

Retention and recruitment efforts, informed by an understanding of the challenges and obstacles faced by transferring women of color, can strategically facilitate engagement in the disciplinary and university communities while focusing on the personal and professional development of future scientists and engineers. Chang (2006), Johnson (2005), Reyes (in press), and Y. Valenzuela (2006) focused on the specific needs, obstacles, experiences, and strategies for the recruitment and retention of women of color in STEM.

Collaborative programmatic efforts between two- and four-year schools for recruiting and retaining women of color in STEM from community colleges holds great promise for diversifying the STEM workforce (Rivera, 2010). Creating more seamless transfers and successful transition programs for underrepresented students from community colleges into STEM fields at universities requires concerted and collaborative leadership within and across the two- and four-year higher education institutions (Rivera, 2010). Much more research on programs that incorporate the strategies responding to the unique challenges, obstacles, and successes of women of color is needed.

Studies have highlighted the importance of social networks and capital on campus for students to be integrated and feel they belong (Auerbach, 2004; Hurtado, Carter, et al., 1996; Hurtado, Han, et al., 2007). Safe or counter spaces have also been helpful for retention (Arbona & Nora, 2007; Heller & Martin, 1994; Reyes, in press; Tate & Linn, 2005; Wawrzynski & Sedlacek, 2003).

For students of color, off-campus social networks that include supportive family and community are also critical for persistence (Hurtado & Carter, 1997). Within a particular setting, programs to engage K–16 youth and families and change the understanding of engineering should include community presentations by engineering professionals and students (Auerbach, 2004).

Assistance with financial aid questions (involving both students and their families) would improve persistence by diminishing the economic concerns that sometimes drive students to seek work off campus and creating pull factors. Financial assistance from paid undergraduate and bridge research opportunities contributes to the student's social capital within STEM on campus and improves persistence.

Practical Recommendations

Recommendations that emerge from the literature cited in this paper are summarized below. Strategies for recruiting and retaining women-of-color transfers into STEM at universities arise from students' stated needs, barriers, obstacles, and success stories.

1. Improve collaborative efforts between two- and four-year schools.
 - a. Create more articulation agreements between community colleges and universities that clearly delineate the disciplinary courses and transfer process for students.
 - b. Include courses and bridge research opportunities on the university campus like the model program for Latinas transferring from Esperanza Community College to Smith College in California (Ornelas & Solorzano, 2004).
 - c. Provide academic skill-building workshops.
 - d. Provide workshops for women of color that focus on management of family and community responsibilities and relationships.
2. Increase the sense of belonging in STEM for women of color.
 - a. Analyze the mission, website, recruiting programs, and college materials for gender- and race-free messages. For instance, are gender, ethnicity, ability, and sexual preference pictured or celebrated? Are examples of the social relevance of STEM careers highlighted?
 - b. Build awareness of family and cultural commitments among faculty and advisers to encourage inclusion of families in programmatic efforts.
 - c. Provide safe or counter-spaces where women of color can discuss and create positive responses to perceived racism, sexism, and other forms of discrimination on campus.
3. Strengthen social networks and capital.
 - a. Provide mentoring in multiple formats (graduate or undergraduate to high school student or middle-school student mentoring, professor to student mentoring, group mentoring, electronic mentoring).

- Foster cultural richness by encouraging participation with ethnic- or gender-affinity groups such as Society of Hispanic Engineers, National Society of Black Engineers, and Society for Advancement of Chicanos and Native Americans in Science. For more information on mentoring, see Amelink (2008).
- b. Increase the presence of role models such as faculty of color (who are supported and acknowledged) on campus and networking with professionals of color in industry.
4. Help with financial aid.
- a. Provide financially supported bridge and undergraduate research opportunities for STEM transfers.
 - b. Provide workshops for students and families in navigating financial aid and university application processes with a special focus on students who don't fit the stereotypical student profile (e.g., married students, single parents, older returning students, transfer students, returning military, handicapped students) to increase recruitment, as reported in Auerbach (2004) with Latino families.

Assessments of efforts that compare participants and nonparticipants of recruitment and retention programs will be essential to determine best practices in improving persistence to graduation. Survey instruments can be used to collect data on quality and applicability of programming components and may be preferable for certain types of data collection; however interviews and focus groups will yield richer and more in-depth information necessary for fine-tuning programs to address specific needs. Survey instruments and interview questions have been included in the pertinent studies cited in this paper (Hurtado & Carter, 1997; Hurtado, Carter, et al., 1996; Reyes, in press; Sy, 2006; Sy & Romero, 2008; Tate & Linn, 2005; Wawrzynski & Sedlacek, 2003).

Areas for future research should include qualitative and quantitative studies (disaggregated by sex and ethnicity) that examine the experiences of women of color in STEM while they are at community colleges and after they transfer to universities. Assessments that compare participants and nonparticipants of recruitment and retention programs will be essential to determine best practices in improving persistence to graduation. Also missing from the literature are studies of women of color in STEM that compare the long-term impact of recruitment and retention programs on participants and nonparticipants.

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