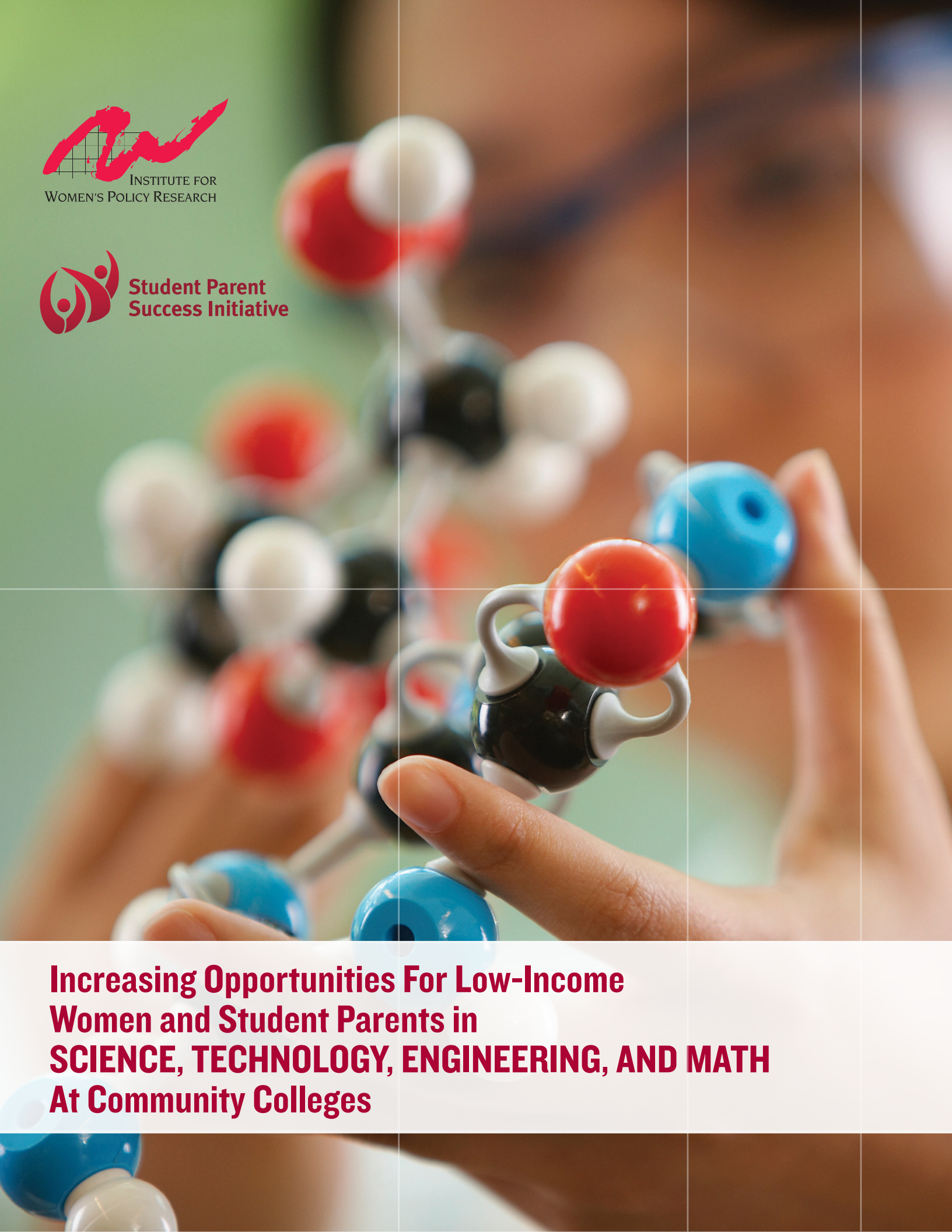

INSTITUTE FOR WOMEN'S POLICY RESEARCH

Student Parent Success Initiative

Increasing Opportunities For Low-Income Women and Student Parents in SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH At Community Colleges

ABOUT THIS REPORT

This report analyzes trends in women's representation in Science, Technology, Engineering, and Math (STEM) fields of study at community colleges, as well as promising institutional and broader policy initiatives for improving recruitment, retention, and completion rates for women students in general and student parents in particular. This report is a product of IWPR's Student Parent Success Initiative, a multifaceted project designed to share knowledge, raise awareness, and improve public policies to support positive outcomes for low-income student parents seeking higher education.

ABOUT THE INSTITUTE FOR WOMEN'S POLICY RESEARCH

The Institute for Women's Policy Research (IWPR) conducts rigorous research and disseminates its findings to address the needs of women, promote public dialogue, and strengthen families, communities, and societies. The Institute works with policymakers, scholars, and public interest groups to design, execute, and disseminate research that illuminates economic and social policy issues affecting women and their families, and to build a network of individuals and organizations that conduct and use women-oriented policy research. IWPR's work is supported by foundation grants, government grants and contracts, donations from individuals, and contributions from organizations and corporations. IWPR is a 501(c)(3) tax-exempt organization that also works in affiliation with the women's studies and public policy programs at The George Washington University.

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Increasing Opportunities for Low-Income Women and Student Parents in SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH at Community Colleges

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Student Parent Success Initiative

Institute for Women's Policy Research

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EXECUTIVE SUMMARY

A number of public policy efforts are focused on increasing the number of U.S. adults with postsecondary credentials, and especially degrees in science, technology, engineering, and math (STEM) fields. Expanded access to STEM careers has the potential to improve the well-being of low-income and working poor families and to strengthen the U.S. economy overall. Efforts to improve economic outcomes through STEM degree attainment, however, are likely to be much more successful if they address and work to ameliorate longstanding segregation by sex and race in STEM education.

Some of the fastest growing occupations in the U.S. economy are in STEM fields with total employment predicted to increase at a considerably faster rate than the labor market as a whole. For example, while overall employment is projected to increase by 10 percent between 2008 and 2018, some STEM sub-specialties are expected to expand by 20 or 30 percent.

Median earnings in STEM occupations tend to be higher, on average, than earnings in the workforce overall for both male and female workers in these fields. Recent research shows that this is particularly true for women, whose earnings are about one-third higher in STEM jobs in comparison to women's earnings in non-STEM work. In 2009, women overall had median annual earnings of $35,633, whereas women's median annual earnings in select STEM fields ranged from $41,091(for engineering technicians) to $71,944 (for electrical and electronics engineers). The gender wage gap does exist in STEM fields, with women earning 14 percent less than men but this gap is smaller than the 21 percent gap found in non-STEM fields. (U.S Department of Commerce, 2011a).

Focusing on STEM fields in postsecondary education presents an important opportunity to improve the economic security of women and families. Community colleges can provide an accessible entry into postsecondary education in STEM fields for low-income working adults and those with dependent children. While some may receive terminal subbaccalaureate degrees others go on to pursue four year degrees. Community colleges award subbaccalaureate credentials—associate's degrees and occupational certificates—in a wide range of STEM disciplines, including engineering, computer and information sciences, and applied science.

Drawing on a literature and program review, analysis of publicly available data, and consultations with experts in the field, this report examines opportunities for women and student parents to pursue and succeed in STEM fields at community colleges. Findings include the following:

- Women with associate's degrees earn only 77 percent of what men earn, in part because of the different fields that men and women pursue, with men more likely to go into STEM fields. Women hold only about one in four STEM jobs. Given that many STEM occupations require advanced degrees or certificates beyond a high school diploma, increasing the proportion of women in STEM jobs requires that more women pursue STEM degrees and certificates at all points along the postsecondary pipeline (including associate's, baccalaureate, and advanced graduate degrees).

- The proportion of women awarded subbaccalaureate degrees and certificates in STEM disciplines is declining, dropping from 33.8 percent in 1997 to 27.5 percent in 2007.

Although women represent a majority of undergraduate students in all settings, community colleges, in particular, attract large numbers of women, many of whom are low-income and have dependent children. For this subset of the student population, the stakes are particularly high. Pursuing fields of study aligned with future careers in STEM fields can provide an important pathway to economic security for student parents and their families, while contributing to the future competitiveness of the U.S. economy.

Community college leadership at many institutions nationwide have implemented a variety of promising approaches to facilitate the pursuit of STEM fields by women, student parents, and other underrepresented students. The goal of these programs is to increase the number of women and other disadvantaged students who successfully complete STEM degrees and certificates and improve transfer rates to four-year institutions. These approaches are as diverse as the institutions sponsoring them and include the following:

- Scholarships and financial incentives for successful completion of coursework at the Community College of Baltimore County, Baltimore, Maryland;
- On-campus child care open until 11:00 p.m., a Head Start program for qualifying students and other emergency assistance at Florence-Darlington Technical College, Florence, South Carolina;
- Developmental courses for students that integrate basic skills instruction with professional-technical courses in fields linked to career pathways in STEM fields at the community and technical colleges in Washington State;
- Coursework innovations including stackable credentials, online learning, and articulation agreements that encourage persistence and completion at Connecticut Community College's College of Technology in Connecticut.
- Extensive academic and support services for women and other educationally disadvantaged students majoring in engineering and other STEM fields at community colleges in California through the MESA Community College Program.

Reversing current trends in women's pursuit of STEM subbaccalaureate degrees and certificates will require community colleges to proactively recruit and retain female students. Broader action will be necessary to ensure that women and student parents are fully integrated at all entry points along the STEM pipeline. For example, research is needed to explore the factors that encourage low-income women and student parents to enter and succeed in STEM fields at community colleges. And supporting the community college pathway to STEM careers for low-income women and other disadvantaged students will require stronger public policies ranging from financial support and child care programs to protections against gender discrimination and new federal investments in STEM programs.

INTRODUCTION

Higher education offers low-income women and student parents a reliable pathway to economic security but women at every education level earn less than men with the same educational backgrounds. Women with associate's degrees earn only 77 percent of what men with the same degrees earn (U.S. Department of Commerce and the Executive Office of the President, 2011). One reason for the relatively muted rewards that women gain from postsecondary education is that men and women tend to enter different fields, with women often pursuing traditionally female, more poorly paid jobs (Carnevale, Strohl, and Melton 2011). Women at the community college level are more likely than men to enroll in educational fields and training for jobs in traditionally female occupations—such as child care workers, health aids, or administrative assistants—with low starting pay, flat wage trajectories, and poor benefits (Hegewisch et al. 2010; Negrey et al. 2001). By contrast, women who train for science, technology, engineering, and math (STEM) fields—fields typically dominated by men—see strong economic returns. A recent report from the U.S. Department of Commerce (2011a) found that, overall, women with STEM jobs earned one-third more than comparable women in non-STEM jobs. This analysis also found that the gap between women's and men's wages was smaller in STEM jobs (14 percent) than in non-STEM jobs (21 percent).

"A recent report from the U.S. Department of Commerce (2011a) found that, overall, women with STEM jobs earned one-third more than comparable women in non-STEM jobs. This analysis also found that the gap between women's and men's wages was smaller in STEM jobs (14 percent) than in non-STEM jobs (21 percent)."

For women raising children as single mothers, whose numbers have risen dramatically in recent years (Wildsmith, Steward-Streng, and Manlove 2011), postsecondary degrees with high labor market value are especially valuable for ensuring family economic security[1] and future opportunities for their children.[2] Efforts to alleviate poverty and economic hardship through postsecondary attainment will yield much greater benefits if women are integrated into higher quality, higher paying degree programs, such as programs within science, technology, engineering, and math at the community college level.

Community colleges provide important postsecondary opportunities to economically disadvantaged students, including low-income women and student parents, because of their affordability, physical accessibility,[3] and open admissions policies compared with four-year institutions. Many community colleges have extensive developmental and remedial programs to help students develop the academic foundation for college success, and offer instruction in a range of educational fields leading to occupational certificates, associate's degrees, or transfer to four-year institutions (Hoffman et al. 2010). In addition many community colleges offer STEM degree programs.

[1] The poverty rate for children living in families headed by women was 44 percent in 2009, up from 39 percent in 2001 (U.S. Department of Health and Human Services 2011).

[2] Research shows that children are more likely to acquire a postsecondary education if their parents have pursued higher education. For example, a study by Attewell and Lavin (2007) found that the children of women who had attended and graduated from the City University of New York were more likely to enroll in postsecondary education than children whose mothers had not graduated from college.

[3] Although there are more four-year institutions than community colleges (2,629 four-year schools versus 1,685 community colleges in 2006–2007), the latter are distributed more evenly across community types: 29 percent of community colleges are located in cities, 29 percent are in rural areas, 24 percent are in towns, and 18 percent are in suburban areas. This geographic distribution of community colleges increases the likelihood that students can find a school close to home and jobs, and readily commute to school (Provasnik and Planty 2008).

Women who choose STEM fields at community college—most of which are nontraditional fields for women—have higher wages than women who pursue many traditional female fields that require similar levels of education. Analysis presented in detail later in this report compares women's earnings in STEM and non-STEM fields that require associate's degrees for entry: for example, the median earnings for women who work as computer support specialists (a STEM field where women make up 28.9 percent of the occupation) are $46,859—significantly higher than the median earnings of $18,759 for women who work as teaching assistants (a non-STEM field where women make up 89.9 percent of the occupation) (U.S. Department of Commerce 2011a). This suggests that women would benefit from pursuing fields tied to high-paying STEM careers even if women are underrepresented in these fields.

"Between 2008 and 2018, the Bureau of Labor Statistics estimates that STEM occupations will grow by 17 percent, while non-STEM occupations will grow by 9.8 percent."

Improving women's access to STEM training and education will also prepare them for high-demand careers. Growth in STEM jobs over the last decade has been three times that of non-STEM jobs (7.9 percent versus 2.6 percent), and projections show strong growth in STEM jobs over the next decade (U.S. Department of Commerce 2011b). Between 2008 and 2018, the Bureau of Labor Statistics estimates that STEM occupations will grow by 17 percent, while non-STEM occupations will grow by 9.8 percent (Ibid.). It is important to note that strong growth is projected for many STEM jobs that require less than a baccalaureate education, such as environmental engineering technicians, biological technicians, and computer support specialists (Bureau of Labor Statistics 2010).

Finally, scientists and policymakers see expanding the STEM pipeline as critical to U.S. economic health. Much of the attention on STEM fields arises from the increasing demand for STEM workers and the relative stagnation in undergraduate and graduate degrees in STEM fields (U.S. Government Accountability Office 2006). While the overall number of degrees in STEM fields has increased in recent decades, they continue to make up only about 17 percent of all postsecondary degrees awarded. The National Science Foundation reports that the United States ranks 20th internationally on the share of 24-year-olds earning degrees in natural science or engineering (Congressional Research Service 2008).

"…scientists and policymakers see expanding the STEM pipeline as critical to U.S. economic health."

In 2007, the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine published a report, *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Future*, which called for strengthening the STEM pipeline from primary through postsecondary education. These professional societies recommended that the nation invest in STEM programs, improve the quality of STEM teachers, and expand the diversity of students in STEM fields—and reiterated these recommendations with the publication of a second report in 2010. A report released by the National Academy of Sciences in 2011, *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*, focused attention on the importance of investing in STEM fields for underrepresented groups.

The federal government has underscored the importance of STEM education to the health of the nation. In November 2009, President Obama launched *Educate to Innovate*, a nationwide effort to help reach the goal of moving American students from the middle to the top of the pack in science and math achievement over the next decade. One of the priorities is to extend STEM education and career opportunities to underrepresented groups, including women and minorities (The White House 2009). More recently, the Administration established an interagency working group focused on implementing effective strategies to ensure compliance with Title IX (the legislation prohibiting sex discrimination in postsecondary education) in STEM programs at institutions of higher education receiving federal funding from federal agencies (DeAro 2010).

Increasing Opportunities for Low-Income Women and Student Parents draws on a literature review, analysis of publicly available data, consultations with experts in the field,[4] and a program review, to examine opportunities for women, including low-income women, and student parents to pursue and succeed in STEM fields at community colleges.[5]

The first section of the report provides background information and data on the demographics of community college students and some of the issues facing low-income women and student parents. Section 2 examines the status of women in the STEM labor force. Data on STEM credentials earned by women and men at the subbaccalaureate level is presented in the third section. Section 4 focuses on promising approaches for women and student parents in STEM fields at community colleges. The report concludes with recommendations for enhancing programs, expanding research, and strengthening policies that can lead to greater opportunities for low-income women and student parents to succeed in STEM fields at community colleges.

Note on definition of STEM fields. STEM fields can include a variety of disciplines. For the most part, this report uses the U.S. Department of Education's definition of STEM fields, which includes math, natural sciences (including physical sciences and biological/agricultural sciences), engineering/engineering technologies, and computer/information sciences. Social sciences and psychology are excluded from this definition. The definition used in this report corresponds with many of the federal and state policies aimed at improving STEM education in the natural sciences, technology, engineering, and mathematics (Chen and Weko 2009).

[4] See Appendix 2 for the list of 16 experts consulted for this report.

[5] Little research to date explores the experiences of women and student parents in STEM programs and fields at community colleges—and the factors that can hinder or promote their success. With a few exceptions (see Lester 2010; Packard et al. 2011), most of the studies are qualitative and have very small samples. Where relevant, findings from these studies are incorporated into this report. More research is needed to determine if the preliminary findings from this research are supported by larger, multi-method studies.

LOW-INCOME WOMEN AND STUDENT PARENTS IN COMMUNITY COLLEGES

SECTION 1

DEMOGRAPHIC SNAPSHOT

In the United States, the student population in postsecondary institutions is quite diverse. Fifty-seven percent of the 16.8 million undergraduate students in the country are women and 38 percent are people of color. It is striking that almost four in ten postsecondary students are low-income (39.8 percent). This translates into 6.7 million undergraduates with household incomes that are less than or equal to 200 percent of the federal poverty level (Miller, Gault, and Thorman 2011).

"Students who are single parents are especially likely to be low-income: almost eight in ten (78 percent) students who are single parents are low-income."

A sizeable portion of college students today are student parents. Analyses conducted by the Institute for Women's Policy Research (IWPR) found that 3.9 million students enrolled in higher education are parents, making up nearly a quarter of postsecondary students overall. Many of these student parents are low-income: Student parents are more likely (57 percent) than postsecondary students overall (39.8 percent) to be low-income. Students who are single parents are especially likely to be low-income: almost eight in ten (78 percent) students who are single parents are low-income. Not surprisingly, women make up the great majority (81 percent) of low-income students who are single parents (Miller, Gault, and Thorman 2011).

"In 2003–2004, about one in four community college students lived in families with very low incomes (125 percent of the poverty level or below)…"

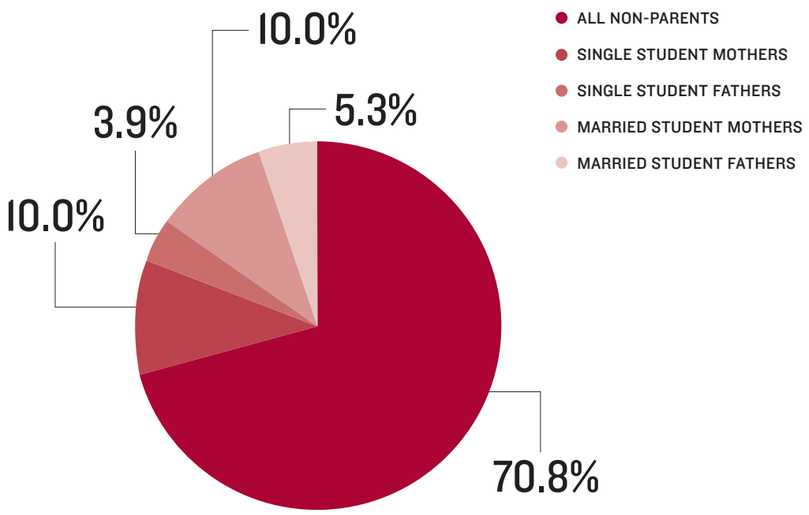
Community colleges have higher proportions of women, low-income students, and student parents compared with four year institutions. Although women make up most students in higher education, they comprise 59 percent of the students at community colleges and 55 percent of the students at four-year institutions (Horn and Nevill 2006). Community college students are also more likely to be low income compared with their counterparts at four-year institutions: In 2003–2004, about one in four community college students lived in families with very low incomes (125 percent of the poverty level or below), while one in five students in four-year institutions were at this income level (Ibid.).

Community colleges also attract large numbers of student parents, most of whom are women. More than twice as many students at community colleges are parents (29.2 percent), compared with the share of student parents at four-year institutions (13 percent) (Miller, Gault, and Thorman 2011). Figure 1 shows that 20 percent of the students at community colleges are women with children, and 10 percent are men with children. One in ten students at community colleges is a woman who is a single parent (Miller, Gault, and Thorman 2011).

"Twenty percent of the students at community colleges are women with children, and 10 percent are men with children. One in ten students at community colleges is a woman who is a single parent."

FIGURE 1

Students Enrolled In Community College, by Gender and Parent Status, 2008



Source: IWPR calculations, 2008 National Postsecondary Student Aid Survey data.

CHALLENGES FACED BY COMMUNITY COLLEGE STUDENTS

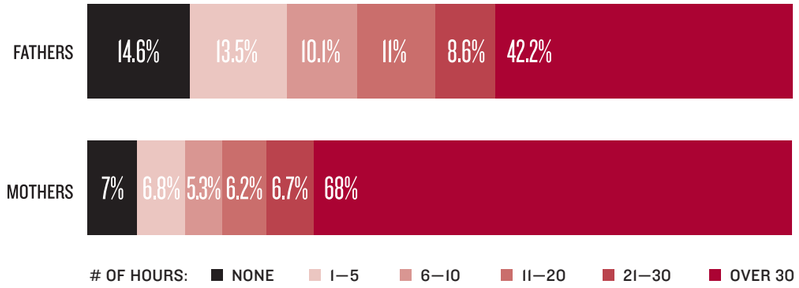
Many students encounter significant challenges at community college including financial and time pressures (Choitz and Widom 2003; Choy 2001). Although community colleges cost less than four-year institutions, many low-income students find them unaffordable. Time constraints can arise from paid jobs and family responsibilities. Most community college students have jobs: about eight in ten (79 percent) work an average of 32 hours per week, and four in ten (41 percent) work full time (Horn and Nevill 2006). And many students with children, especially women with children, spend many hours a week caring for them (Miller, Gault, and Thorman 2011). Figure 2 shows that almost seven in ten (68 percent) mothers attending community colleges spend 30 hours a week or more caring for dependents, compared to 42 percent of fathers.

"…almost seven in ten (68 percent) mothers attending community colleges spend 30 hours a week or more caring for dependents, compared to 42 percent of fathers."

Research shows that time and money pressures lead many students to drop out of community college, or to "stop out" and return later (Choitz and Widom 2003; Pusser and Levin 2009). A study of first-time freshmen who entered community college during 2003–2004 found that, three years later, 40 percent were still enrolled but had not completed a degree or certificate and 45 percent had left school without earning a credential. Among first-time freshmen who intended to transfer to a four-year school, 39 percent had left school without completing a degree or certificate program (Provasnik and Planty 2008).

FIGURE 2

Hours per Week Spent on Care by Fathers and Mothers in Community College, 2008



Source: IWPR Calculations, 2008 Community College Survey of Student Engagement data.

Policymakers, foundations, and researchers have called for a broad range of reforms to improve student persistence and completion at community colleges (McIntosh and Rouse 2009). Some of these innovations address the need to improve developmental education for students who require remedial help before starting college-level courses (Bailey 2009). Others focus on the importance of increasing financial aid and expanding child care services for student parents (Choitz and Widom 2003; Miller, Gault, and Thorman 2011). And still others address the need to create educational pathways at community colleges that can encourage students to progress from developmental education to earning credentials in high-return fields of study (Furchtgott-Roth, Jacobson, and Mokher 2009).

"A study of first-time freshmen who entered community college during 2003–2004 found that, three years later, 40 percent were still enrolled but had not completed a degree or certificate and 45 percent had left school without earning a credential."

WOMEN IN THE STEM LABOR FORCE

SECTION 2

PROJECTED GROWTH OF STEM OCCUPATIONS

STEM fields offer career opportunities for women, including low-income women and student parents, in a sector of the labor force that is projected to have strong growth in the years ahead. The Bureau of Labor Statistics (2010) projects that many STEM fields will grow twice as fast as the average growth rate of 10 percent between 2008 and 2018: computer and mathematical occupations are estimated to increase by 22 percent, while occupations in life and physical sciences are projected to grow by 19 percent. Slower growth rates are projected for engineering occupations (11 percent) although certain engineering specialties are projected to have very high growth rates: biomedical engineers (72 percent) and computer software engineers (34 percent).

The STEM labor force is composed of occupations requiring different levels of education. Many STEM occupations, including engineering, computer science, physics, and the biological sciences, require a bachelor's level of education or more (Bureau of Labor Statistics 2010). Other STEM careers require only an associate's degree or occupational certificate from a community college. Examples include engineering technicians who assist engineers in developing new products; computer support specialists and systems administrators who provide administrative and technical assistance to computer users; and biological technicians who work as laboratory assistants (Bureau of Labor Statistics 2010). Tsapogas (2004) notes that more than one-fifth of all individuals employed in science and engineering occupations have less than a bachelor's degree.

The Bureau of Labor Statistics (2010) reports that several STEM occupations requiring a subbaccalaureate credential (an associate's degree or certificate) will have strong growth rates between 2008 and 2018. Figure 3 shows that the estimated growth rates are 30 percent for environmental engineering technicians and 18 percent for biological technicians. A slower growth rate is projected for computer support specialists (14 percent) but this is still higher than the growth rate of 10 percent projected for the labor force as a whole.

WOMEN'S REPRESENTATION IN STEM OCCUPATIONS

Although women make up close to half of the labor force, only one in four STEM jobs is held by a woman. Over the last decade, women's share of different STEM jobs has varied by field. The proportion of women in computer and math jobs (the largest STEM field) dropped from 30 to 27 percent between 2000 and 2009. In 2009 only one in seven engineers was a woman, and engineering is the second largest STEM occupational group. Women have increased their representation in physical and life sciences jobs, where they now make up about 40 percent of the workforce, up from 36 percent in 2000 (U.S. Department of Commerce 2011a).

"Women have increased their representation in physical and life sciences jobs, where they now make up about 40 percent of the workforce, up from 36 percent in 2000 ."

FIGURE 3

Projected Growth in Employment in Selected STEM Occupations, 2008–2018

Source: Bureau of Labor Statistics. 2010b. Occupational Outlook Handbook, 2010-11 Edition.

Table 1 shows that the proportion of women in STEM fields varies across occupations and educational requirements: women comprise only 11.9 percent of civil engineers and 8.8 percent of electrical and electronics engineers although their proportion of engineering technicians is 16 percent. Women fare better in the computing occupations where they make up 19.9 percent of computer software engineers and 28.9 percent of computer support specialists. A large share of biological technicians is women (41.4 percent).

WOMEN'S EARNINGS IN STEM OCCUPATIONS

Women who work in STEM occupations have higher median annual earnings compared to average wages for women in the United States. A recent analysis of the American Community Survey by the U.S. Department of Commerce (2011a) found that the earnings for women with STEM jobs are 33 percent higher than the earnings for comparable women in non-STEM jobs. For men, the earnings premium for STEM jobs is smaller: those who work in STEM jobs earn 25 percent more than their counterparts in non-STEM jobs.

Table 1 shows women's earnings in STEM and non-STEM occupations that require bachelor's or associate's degrees. Not surprisingly, STEM occupations requiring higher levels of education (a baccalaureate degree) pay more than those requiring less education (an associate's degree or certificate), but the latter have relatively high earnings as well. In 2009, women's median annual earnings in selected STEM occupations ranged from $41,091 for engineering technicians to $71,944 for electrical and electronics engineers, considerably higher than the median annual earnings for women workers overall of $35,633.Still, women's median annual earnings in these STEM occupations lag behind the median earnings of men: women STEM workers

TABLE 1

Women's Median Annual Earnings and Share in Selected STEM and Non-STEM Occupations by Educational Requirements, 2009

	MEDIAN ANNUAL EARNINGS FOR MEN ($)	MEDIAN ANNUAL EARNINGS FOR WOMEN ($)	WOMEN'S EARNINGS AS PERCENT OF MEN'S EARNINGS	SHARE OF FEMALE WORKERS IN OCCUPATION
ALL WORKERS	$45,872	$35,633	77.7%	43.2%
STEM OCCUPATIONS:				
OCCUPATIONS REQUIRING BACCALAUREATE DEGREE				
ELECTRICAL AND ELECTRONICS ENGINEERS	$83,303	$71,944	86.4%	8.8%
COMPUTER SOFTWARE ENGINEERS	$89,519	$77,878	87.0%	19.9%
CIVIL ENGINEERS	$78,327	$63,619	81.2%	11.9%
OCCUPATIONS REQUIRING ASSOCIATE'S DEGREE				
COMPUTER SUPPORT SPECIALISTS	$50,802	$46,859	92.2%	28.9%
ENGINEERING TECHNICIANS, EXCEPT DRAFTERS	$52,476	$41,091	78.3%	16.0%
BIOLOGICAL TECHNICIANS	$44,527	$42,483	95.4%	41.1%
NON-STEM OCCUPATIONS:				
OCCUPATIONS REQUIRING BACCALAUREATE DEGREE				
ELEMENTARY AND MIDDLE SCHOOL TEACHERS	$50,400	$46,029	91.3%	77.7%
REGISTERED NURSES	$67,280	$59,778	88.8%	89.1%
SOCIAL WORKERS	$41,715	$39,236	94.1%	78.4%
OCCUPATIONS REQUIRING ASSOCIATE'S DEGREE				
TEACHER'S ASSISTANTS	$25,916	$18,759	72.4%	89.9%
LICENSED PRACTICAL AND VOCATIONAL NURSES	$41,091	$36,997	90.0%	91.7%
PARALEGALS AND LEGAL ASSISTANTS	$44,623	$42,932	96.2%	86.5%

Note: For educational requirements for different occupations, see Bureau of Labor Statistics. Occupational Outlook Handbook, 2010-11 Edition.

Source: IWPR compilation of data from the U.S. Department of Commerce, Bureau of the Census, American Community Survey, 2009, "B24122 and B24123: Detailed occupation by median earnings in the past 12 months (in 2009 inflation-adjusted dollars) for the full-time, year-round civilian employed male/female population 16 years and over - universe: full-time, year-round civilian employed male/female population 16 years and over with earnings," and "B24125 and B24126: Detailed occupation for the full-time, year-round civilian employed male/female population 16 years and over - universe: full-time, year-round civilian employed male/female population 16 years and over," <http://factfinder.census.gov/home/saff/main.html?_lang=en> (accessed March 30, 2011).

earn, on average, 86 percent of what men STEM workers earn (U.S. Department of Commerce 2011a). The wage gap is highest among engineering technicians, where women earn 78.3 percent of what men earn, and lowest among biological technicians where women's earnings are 95.4 percent of men's. Whether these wage gaps are the result of sex discrimination or other factors deserves further attention.

It is important to note, however, that women's median annual earnings in most STEM fields are higher than what women earn in most occupations that are female-dominated. Table 1 shows the difference in earnings among women in male-dominated and female-dominated occupations that require an associate's degree or certificate. Women make up only about 29 percent of computer support specialists, but their median earnings in these positions are $46,859. By contrast, women comprise 89.9 percent of teaching assistants, but their median earnings in these jobs are

only $18,759—less than half of the earnings of computer support specialists. These findings demonstrate that a woman's decision about which educational field to pursue can have a significant impact on her future earnings. A recent report released by the Georgetown University Center for Education and the Workforce (Carnevale, Smith, and Melton 2011) concluded that increasing the numbers of women and minorities in STEM fields is an effective strategy for creating more equal opportunity in the labor market. Although women and minorities are underrepresented in STEM fields, the payoff is significant for those who enter and persist in these fields. The wage gap between women and minorities, on the one hand, and white men on the other, is smaller in STEM fields than in any other set of occupations (Carnevale, Smith, and Melton 2011; U.S. Department of Commerce 2011a).

"…a woman's decision about which educational field to pursue can have a significant impact on her future earnings."

SECTION 3

WOMEN'S REPRESENTATION IN STEM FIELDS AT COMMUNITY COLLEGES

In the last decade, research has started to focus on the role of community colleges in expanding the number of STEM professionals. A report published by the National Academy of Engineering and the National Research Council in 2005, *Enhancing the Community College Pathway to Engineering Careers*, highlights the important role of community colleges as stepping stones for underrepresented groups that might not have considered careers in engineering. And a report published by the National Academy of Sciences in 2011, *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*, explores the importance of the community college pathway to STEM fields and careers for minority students.

Community colleges award subbaccalaureate credentials—associate's degrees and occupational certificates—in a wide range of STEM disciplines, including engineering, computer and information sciences, and applied science. Associate's degrees in STEM fields typically take two full-time years to finish, while short-term STEM certificates require less than a year and medium-term STEM certificates require between one and two years to complete. The actual time students take to earn an occupational certificate or associate's degree depends upon whether they attend school part-time or full-time, and whether they stop out or leave school for a period of time (Horn and Li 2009).

Analyses of the Integrated Postsecondary Education Data System (IPEDS) (data collected by the National Center for Education Statistics at the U.S. Department of Education) show that women are underrepresented in earning subbaccalaureate credentials in most STEM fields, and they have been losing ground over the last decade. Between 2000–2001 and 2008–2009, the number of women earning associate's degrees in STEM fields decreased by 25.7 percent whereas the number of women earning short- and medium- term STEM certificates decreased by about 50 percent. This contrasts with the progress made by women at the baccalaureate and graduate levels in STEM fields during this period when the number of women earning bachelor's degrees increased by 17 percent, and the number of women earning master's degrees and doctorate's in STEM fields increased by 30.4 percent and 78.9 percent respectively (U.S. Department of Education 2011a). Further research is needed to determine why women have made progress in STEM fields at the baccalaureate and graduate levels while losing ground at the community college level.

"Between 2000–2001 and 2008–2009, the number of women earning associate's degrees in STEM fields decreased by 25.7 percent."

Several types of data on women's representation in STEM fields at the subbaccalaureate level are presented below: (1) women earning subbaccalaureate awards (combining occupational certificates and associate's degrees), (2) women earning occupational certificates, (3) women earning associate's degrees, and (4) the community college experience of STEM graduates with baccalaureate and master's degrees.

WOMEN EARNING SUBBACCALAUREATE AWARDS

In 2007, subbaccalaureate awards in STEM fields (certificates and associate's degrees combined) accounted for 8.6 percent of all subbaccalaureate awards. A total of 126,783 subbaccalaureate awards were made in STEM fields (Horn and Li 2009). In an analysis of IPEDS, Horn and Li (2009) report that the share of subbaccalaureate awards in STEM disciplines declined by 10.4 percent between 1997 and 2007.

"In 2007, women earned only 27.5 percent of all subbaccalaureate awards in STEM fields, down from 33.8 percent in 1997."

Horn and Li's analysis shows that women are underrepresented in all but one STEM field and have been losing ground in receipt of subbaccalaureate awards over the last decade. In 2007, women earned 27.5 percent of all subbaccalaureate awards in STEM fields, down from 33.8 percent in 1997. The proportion of women earning subbaccalaureate awards in STEM fields increased in only one category ("other STEM fields"[6]) during the decade, where women's share jumped from 39 percent to 46.3 percent. The most significant drop in women receiving subbaccalaureate awards was in computer and information technology, where numbers decreased from 56 percent to 31 percent (see Figure 4, Table 2). According to Horn and Li (2009), this decline may be the result of a parallel decline in the number of jobs in data entry and computer operations during this period, occupations where women have predominated.

"The most significant drop in women receiving subbaccalaureate awards was in computer and information technology, where numbers decreased from 56 percent to 31 percent."

TABLE 2
Percent Distribution of STEM Subbaccalaureate Awards by Gender, 1997, 2002, 2007

	1997		2002		2007	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
STEM TOTAL	**66.2**	**33.8**	**69.5**	**30.5**	**72.5**	**27.5**
COMPUTER AND INFORMATION SCIENCES	43.8	56.2	61.4	38.6	69.3	30.7
ENGINEERING, ENGINEERING TECHNOLOGY	85.2	14.8	84.0	16.0	85.9	14.1
MATHEMATICS AND SCIENCE	46.9	53.1	48.0	52.0	50.3	49.7
OTHER STEM*	61.0	39.0	58.9	41.1	53.7	46.3

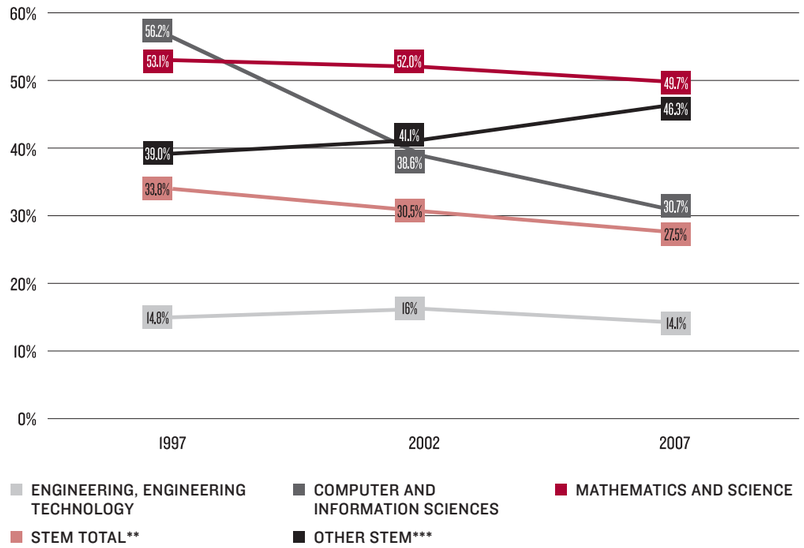
Note: Subbaccalaureate awards include associate's degrees and occupational certificates. Detail may not sum to totals because of rounding.

*Other STEM fields include agricultural sciences, natural resources, biological and physical sciences, and other fields.

Source: Adapted from the U.S. Department of Education, National Center for Education Statistics, November 2009, Stats in Brief: Changes in Postsecondary Awards Below the Bachelor's Degree: 1997-2007 (NCES 2010-167), "Table 5: Percentage distribution of subbaccalaureate awards conferred in Title IV postsecondary institutions by gender, award type, race/ethnicity, and field of study: 1997, 2002, and 2007." (Data from National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), "Completions Survey" and "Institutional Characteristics Survey," 1997, 2002, and 2007).

[6] Other STEM fields include agricultural sciences, natural resources, biological and physical sciences, and other fields.

FIGURE 4
Women's Share of Subbaccalaureate Awards in Selected STEM Fields, 1997, 2002, 2007*



* Subbaccalaureate awards include associate's degrees and occupational certificates

** Science, technology, engineering, and mathematics.

*** Other STEM fields include agricultural sciences, natural resources, biological and physical sciences, and other fields

Note: Detail may not sum to totals because of rounding.

Source: Adapted from the U.S. Department of Education, National Center for Education Statistics, November 2009, Stats in Brief: Changes in Postsecondary Awards Below the Bachelor's Degree: 1997-2007 (NCES 2010-167), "Table 5: Percentage distribution of subbaccalaureate awards conferred in Title IV postsecondary institutions by gender, award type, race/ethnicity, and field of study: 1997, 2002, and 2007." (Data from National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), "Completions Survey" and "Institutional Characteristics Survey," 1997, 2002, and 2007.)

WOMEN EARNING OCCUPATIONAL CERTIFICATES

Occupational certificate programs are typically part of the career and technical education function of community colleges. Initially passed by Congress in 1984, the Carl D. Perkins Act authorizes the U.S. Department of Education to provide funding to states for secondary and postsecondary career and technical education (CTE), including programs in STEM fields at community colleges (Lester 2010). Linked to preparation for employment in specific occupations or careers, most CTE programs are subbaccalaureate programs that can be completed in a relatively short time, ranging from a few months to several years. Upon completion of a postsecondary program of study in a career field, students typically receive a certificate that may also lead to further education. Adults also may enroll in CTE programs to update or acquire new job skills (Levesque et al. 2008).

Women have been losing ground in receipt of occupational certificates in STEM fields over the last decade. A recent analysis of IPEDS data shows that between

2000–2001 and 2008–2009, the number of women earning short-term certificates (requiring less than one year to complete) and medium-term certificates (requiring at least one year but less than two years to complete) in STEM fields declined by half. Awards of short-term certificates to women in STEM fields dropped from 9,345 to 4,675 while awards of medium-term certificates in STEM fields declined from 6,803 to 3,142 (U.S. Department of Education 2011a).

While more detailed information on women's receipt of occupational certificates in specific STEM fields is unavailable, the National Postsecondary Student Aid Survey (NPSAS), collected by the U.S. Department of Education (DOE), contains data on the specific fields that first-year students plan to pursue. DOE's analysis of this data showed that women comprised 63.8 percent of undergraduates seeking occupational certificates overall in the academic year 2007–2008. Not surprisingly, women were most heavily represented among those seeking certificates in fields considered "traditional" for their gender: consumer services (86.7 percent female), health sciences (84.6 percent female), and education (73.8 percent female) (U.S. Department of Education 2007–2008).

Among first-year students, women comprised fairly high proportions of those planning to pursue certificates in certain STEM fields: 42.5 percent in computer and information sciences and 52.6 percent in agriculture and natural resources. By contrast, women's share of those seeking certificates in engineering and architecture was only 7.6 percent. These data suggest that in at least some STEM fields, such as computer and information sciences, some women who plan to earn an occupational certificate do not actually do so.[7] Further research is needed to determine the barriers that deter women from earning certificates in STEM fields. Because the factors may differ across disciplines, it is important that this analysis examine women's experience in different STEM fields.

"Very small percentages of associate's degrees in STEM fields were awarded to African American women (3.3 percent); Hispanic women (2.2 percent); and Asian, Native Hawaiian, and Pacific Islander women (1.3 percent)."

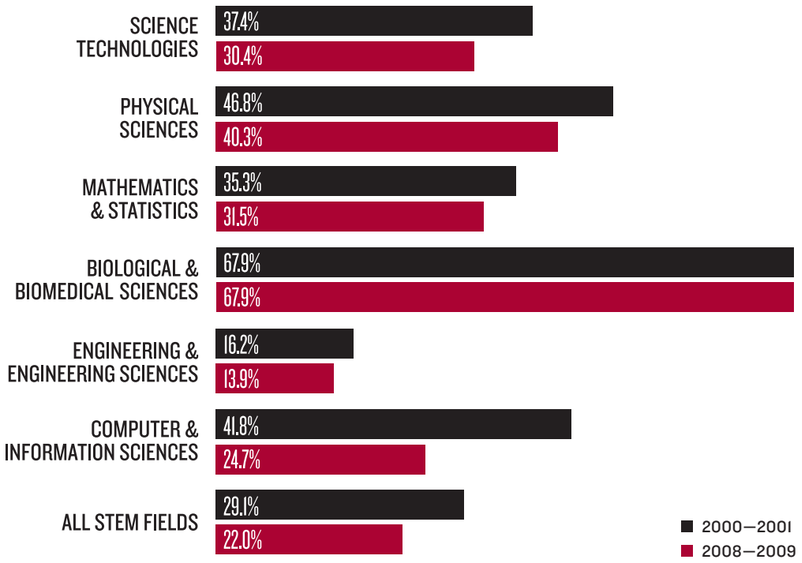
WOMEN EARNING ASSOCIATE'S DEGREES

Students can earn associate's degrees at community college in a wide range of STEM fields. These associate's degrees can serve as the entry credential for many occupations, including engineering technicians, computer support specialists, and biological technicians (Bureau of Labor Statistics 2010). In addition, associate's degrees in STEM fields can provide the basis for transferring to a four-year institution to earn a baccalaureate degree.

Figure 5 shows that the percentage of associate's degrees in STEM fields awarded to women declined from 29.1 percent in 2000–2001 to 22 percent in 2008–2009. Women lost the greatest ground in computer and information sciences where their share of associate's degrees dropped from 41.8 percent to 24.7 percent during this period. More modest declines occurred in every other STEM field, with the exception

[7] Although data are not available on the percentage of women earning occupational certificates by STEM field, the data reported above on subbaccalaureate awards (including both certificates and associate's degrees) shows that women comprise 31 percent of those earning subbaccalaureate awards in computer and information sciences—more than 10 percent less than the 42.5 percent of women who reported their intention to pursue a certificate in this field.

FIGURE 5
Percentage of Associate's Degrees Awarded to Women by STEM Field, 2000-2001 and 2008-09



Source: U.S. Department of Education. National Center for Education Statistics. Postsecondary Awards in STEM by State, 2001 and 2009 (NCES 2011-226), Tables 9b and 9d.

of biological and biomedical sciences where women continued to receive more than two out of three awards (67.9 percent).

There are very little data on receipt of associate's degrees in STEM fields by women of color.[8] One exception is an analysis of the IPEDS showing that white women earned the largest share (13.9 percent) of associate's degrees in STEM fields in 2009. Very small percentages of associate's degrees in STEM fields were awarded to African American women (3.3 percent); Hispanic women (2.2 percent); and Asian, Native Hawaiian, and Pacific Islander women (1.3 percent) (see Table 3).

African American women fared the best in earning associate's degrees in science technologies (5.9 percent), computer and information sciences (5.3 percent), and biological and biomedical sciences (5.2 percent). Hispanic women were most strongly represented in the biological and biomedical sciences (11.5 percent), followed by mathematics and physical sciences (5.9 percent). Women who are Asian, Native Hawaiian, or Pacific Islanders earned larger shares of associate's degrees in the fields of biological and biomedical sciences (9.8 percent) and the physical sciences (6.3 percent).

[8] Very little research has focused on the experience of women of color in STEM fields. An article by Reyes (2011) examined the experience of a small group of women of color who had transferred from community college to a four-year institution in STEM fields. These women reported "attitudes and treatment [by faculty, advisers, and peers] signaling that they do not belong because of age, ethnicity, and gender as well as preconceptions that transfer students are not adequately prepared."

TABLE 3

Associate's Degrees Awarded to Women in STEM Fields by Race and Ethnicity, Academic Year 2008–2009

FIELD OF STUDY*	NUMBER OF WOMEN	PROPORTION OF ASSOCIATE'S DEGREES AWARDED TO WOMEN	PERCENT AMERICAN INDIAN OR ALASKA NATIVE	PERCENT ASIAN, NATIVE HAWAIIAN, OR PACIFIC ISLANDER	PERCENT BLACK OR AFRICAN AMERICAN	PERCENT HISPANIC OR LATINO	PERCENT WHITE	PERCENT TWO OR MORE RACES**	PERCENT OF RACE/ ETHNICITY UNKNOWN	PERCENT NONRESIDENT ALIEN
ALL STEM FIELDS	**17,424**	**23.2%**	**0.4%**	**1.3%**	**3.3%**	**2.2%**	**13.9%**	**0.0%**	**1.5%**	**0.5%**
COMPUTER AND INFORMATION SCIENCES AND SUPPORT SERVICES	7,453	24.8%	0.4%	1.0%	5.3%	2.0%	13.5%	0.0%	2.1%	0.5%
ENGINEERING	311	14.3%	0.2%	1.5%	1.4%	2.5%	6.5%	0.0%	0.8%	1.4%
ENGINEERING TECHNOLOGIES/ TECHNICIANS	4,291	14.1%	0.2%	0.6%	1.9%	1.6%	9.1%	0.0%	0.4%	0.2%
BIOLOGICAL AND BIOMEDICAL SCIENCES	1,608	68.0%	1.6%	9.8%	5.2%	11.5%	33.4%	0.1%	4.6%	1.8%
MATHEMATICS AND STATISTICS	295	31.7%	0.3%	5.8%	1.1%	5.9%	15.5%	0.0%	1.6%	1.5%
PHYSICAL SCIENCES	918	41.9%	0.6%	6.3%	2.8%	4.8%	21.6%	0.0%	2.7%	3.0%
SCIENCE TECHNOLOGIES/ TECHNICIANS	579	40.6%	0.1%	2.4%	5.9%	3.5%	26.2%	0.0%	1.6%	0.9%
AGRICULTURE, AGRICULTURE OPERATIONS, AND RELATED SCIENCES	1,654	36.6%	0.5%	0.5%	0.4%	0.9%	31.4%	0.0%	2.7%	0.1%
NATURAL RESOURCES AND CONSERVATION	315	26.3%	1.4%	0.6%	0.3%	0.7%	22.1%	0.0%	1.1%	0.1%

Note: Degrees conferred to individuals of Hispanic or Latino ethnicity are included in the Hispanic or Latino category regardless of race.

* Degrees by field of study (2-digit Classification of Instructional Programs [CIP] level) are based on the 2000 version of the CIP.

** Two or more races was an optional reporting category in IPEDS 2009-10, and 251 institutions reported awarding degrees or certificates using this option. The figures reported here should not be considered representative of all completions awarded to individuals who could be classified into two or more races.

Source: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), Fall 2009, Completions components. "Table 63. associate's degrees conferred by Title IV institutions, by race/ethnicity, field of study, and gender: United States, academic year 2008-09.

COMMUNITY COLLEGE EXPERIENCE OF STEM GRADUATES WITH BACCALAUREATE AND MASTER'S DEGREES

Little data are collected on the community college experience of students receiving undergraduate and graduate degrees in STEM fields. An exception is the National Survey of Recent College Graduates (NSRCG), collected by the National Science Foundation's (NSF), which includes data on the community college experience of graduates receiving a bachelor's or master's degree in science and engineering.[9] It is important to note that these data do not distinguish between graduates who attended community college full-time and those who took just one course. In 2006–2007, about half (50.3 percent) of STEM graduates with bachelor's or master's degrees had attended community colleges, with higher percentages of those with bachelor's degrees (52.2 percent) than master's degrees (43 percent) having attended community college (Mooney and Foley 2011).

"In 2006–2007, about half (50.3 percent) of STEM graduates with bachelor's or master's degrees had attended community colleges…"

[9] The NSRCG includes social and related sciences in STEM fields, and the most recent NSRCG 2008 includes graduates in health fields and is therefore not strictly comparable to earlier data sets, which excluded graduates in health fields. See Mooney and Foley (2011).

Few STEM graduates with bachelor's or master's degrees attended community college in order to earn an associate's degree. Less than one-third (29 percent) of science and engineering graduates (including both bachelor's and master's graduates) stated that their reason for attending community college was to earn an associate's degree. Mooney and Foley (2011) note that the most significant reason given for attending community college was to earn credits toward a bachelor's degree (reported by 75 percent of graduates), followed by financial reasons (44 percent), to gain further skills or knowledge in academic or occupational field (42 percent), and to prepare for a four-year college (42 percent). About equal proportions of STEM graduates attended community college after high school before enrolling in a four-year institution (43 percent) and attended community college while enrolled in a four-year institution (45 percent) (Mooney and Foley 2011).

In other words, among those STEM graduates who had attended community college, about half were community college students while the other half were enrolled in four-year institutions while taking one or two courses at a community college.

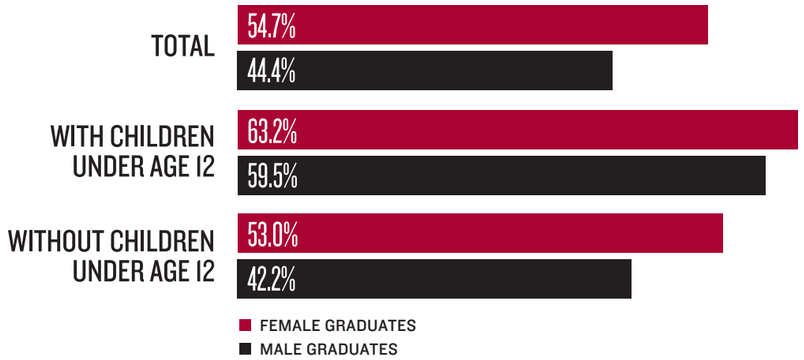
"More than six in ten (63.2 percent) female graduates with children under the age of 12 in the household who earned a bachelor's or master's degree in a STEM field had attended community college, compared with 53 percent of those without children in the household."

Female STEM graduates, especially those with children, had higher rates of attendance at community college than men did. Female graduates with baccalaureate or master's degrees in STEM fields were more likely (54.7 percent) than their male counterparts (44.4 percent) to have attended community college. Attendance at community college among science and engineering graduates was especially high among women with children. More than six in ten (63.2 percent) female graduates with children under the age of 12 in the household who earned a bachelor's or master's degree in a STEM field had attended community college, compared with 53 percent of those without children in the household. The proportion of male graduates who had attended community college was 59.5 percent for those with children in the household and 42.2 percent for those without children (see Figure 6).

The data presented above show that women are underrepresented in most STEM fields at community colleges and, especially troubling is the fact that women have been losing ground over the last decade in most STEM fields. Women's underrepresentation in STEM fields is even more pronounced for women of color. These data also suggest that community colleges can play an important role for women—and especially for women with dependent children—who are interested in earning a baccalaureate (or master's) degree in a STEM field.

FIGURE 6

Prior Attendance at Community Colleges by Baccalaureate and Master's Degree Recipients in STEM Fields by Gender and Parent Status, 2008



Source: National Science Foundation (NSF). National Center for Science and Engineering Statistics, National Survey of College Graduates 2008, Special tabulations by NSF, July 27, 2011.

SECTION 4

PROMISING APPROACHES FOR PROMOTING WOMEN'S PARTICIPATION AND SUCCESS IN STEM FIELDS AT COMMUNITY COLLEGES

A. WHY WOMEN ARE UNDERREPRESENTED IN STEM FIELDS IN COMMUNITY COLLEGES

Research on women's entry into and representation in STEM fields suggests that several factors are at play in the low representation of women in STEM careers, including a lack of visible female role models (McIntyre, 2005), a need for more varied pedagogical approaches that more effectively engage women (Hill, Corbett and St. Rose 2010; Osborne, Miller, and Farabee-Siers 2008), and the need for active recruitment and programming, starting at young ages (Whitten, Foster, and Duncombe 2004; Milgram 2011). In addition, as women bear a disproportionate responsibility for care giving within families, and are much more likely than men to be single parents (U.S Department of Commerce and the Executive Office of the President, 2012), efforts to attract and retain women in STEM fields must take their caregiving roles into account.

A number of questions about the STEM experiences of women in community colleges remain to be answered. Do gender stereotypes or lack of female role models discourage women from entering STEM fields in community college? Do some women view the demands of STEM fields—and the perceived lack of flexibility in these careers—as incompatible with family commitments? Or, do community colleges fall short in recruiting and supporting women to enter STEM fields? Unfortunately, research on these and other relevant questions is in short supply. Additional analysis is needed to more definitively answer these questions, and to guide programmatic and policy action that will increase women's representation in STEM fields at community colleges. Existing research focused on access to community college point to several sets of difficulties encountered by low-income individuals and women in pursuing STEM and other fields of study at community colleges.

- Financing: Despite lower relative costs compared with four-year institutions, many community college students struggle to patch together sufficient resources to finance their educations (Choy and Bobbitt 2000), and this difficulty is likely to be even greater for students supporting children. Pell Grants, one of the principal sources of federal student aid for low-income postsecondary students, provide smaller awards for part-time students and do not incorporate room and board into financial need estimates.

- Child care: Affordable, convenient, quality child care is a crucial ingredient for student parents. On-campus child care centers, however, provide only about 5 percent of the child care required by student parents (Miller, Gault and Thorman 2011).

- Developmental education: Many community college students require remedial coursework to prepare for the college-level mathematics courses that provide the foundation for most STEM programs (Hagedorn and DuBray 2010).

- Counseling, advising, and academic supports: Many disadvantaged students at community colleges, including student parents, require more intensive academic advising and supports to develop clear academic goals and a clear understanding of the requirements for degree attainment (Henrici 2009).

- Curriculum and instruction: Conventional curricula and teaching methods may run counter to women's style of learning and skill acquisition. Nontraditional approaches including greater collaboration and teamwork, equal gender participation in lab modules and better application to real-world problems can encourage women's success in the classroom (Hill, Corbett and St. Rose 2010; Osborne, Miller, and Farabee-Siers 2008).

- Educational pathways: Student parents must balance degree requirements with work and family obligations, which may serve as obstacles to continuous attendance and impede timely degree completion. Structuring coursework in a series of "chunks" culminating in stackable credentials allows these students to accrue marketable credentials even if community college attendance is periodically interrupted.

B. PROMISING PROGRAMS FOR ADDRESSING OBSTACLES TO STEM PARTICIPATION

This section of the report identifies promising approaches in STEM education at community colleges that support the success of women, including low-income women and student parents. It focuses on several dimensions of STEM education that appear important to women's entry into and persistence in STEM fields: (1) recruitment strategies, (2) financial supports and child care, (3) developmental education, (4) counseling, advising, and academic supports, (5) educational pathways, and (6) curriculum and instruction.

Based on a review of the program literature and interviews with experts in the fields, this report identifies seven programs that illustrate promising approaches in STEM education to highlight in this report. Snapshots of these programs are incorporated below and more detailed summaries are included in Appendix 1. No doubt, there are many other promising programs that deserve attention. Several criteria were used to select these programs:

- Programs that target women, or include a significant number of women.

- Programs that focus on different levels of STEM education—developmental education, occupational certificates, associate's degrees, and preparation for transfer to four-year institutions.

- Programs with a range of components to supporting women's success, including approaches benefiting low-income women and student parents.

- Programs from different regions of the country.

- Programs with some evaluation and outcome data, or evidence of success.

We found that most STEM programs in community colleges have not been rigorously evaluated. The strongest program evaluations use experimental or quasi-experimental designs to "test" the effect of different program models on student outcomes (e.g., completing courses, grades, receiving certificates and awards, etc.). The next best approach uses multivariate methods to analyze large data sets in order to determine the effect of certain variables (e.g., the presence versus absence of financial aid, child care, etc.) on student outcomes (e.g., completing courses, receiving certificates and awards, etc.) for certain populations (e.g., women versus men). The I-BEST program was the only program profiled in this report to use these more rigorous methods to analyze outcomes. The other programs reported some participation or outcome data.

Three of the programs included in this section are supported by the National Science Foundation (NSF) Advanced Technological Education Program (ATE): the Grace Hopper Scholars Program in Math and Computer Science, the South Carolina Advanced Technological Education Center, and the Regional Center for Next Generation Manufacturing. Established through the 1992 Scientific and Advanced-Technology Act, ATE supports the education of students in STEM fields at community colleges, professional development of college faculty and secondary school teachers, curriculum development in STEM fields, and career pathways from high school to two-year colleges and from two-year colleges to four-year institutions (Patton 2008).

Since 1992, ATE has funded hundreds of STEM programs at community colleges and support centers nationwide. NSF strongly encourages ATE grantees to develop strategies and support services to increase participation among traditionally underrepresented groups, including those who are low income, ethnic and racial minorities, persons with disabilities, and women (Starobin and Laanan 2008). In 2009, ATE-funded programs served 85,300 students: 52 percent of students were at two-year colleges, 45 percent were nonwhite, and 27 percent were women (Wingate, Westine, and Gullickson 2010).

Two STEM programs profiled here—the CALWomenTech Extension Services Project and the STEM Equity Pipeline—are rooted in nontraditional education and employment for women. Most nontraditional education programs for women were initially funded through the Carl D. Perkins Act of 1984. When first authorized, the Perkins Act included set-aside funding for single parents, displaced homemakers, and individuals entering nontraditional occupations such as electricians, plumbers, construction workers, etc. Reauthorizations of the Carl D. Perkins Act eliminated the set-asides and many of the programs targeted to women disappeared (Hardy and Katsinas 2010). This funding stream, however, has continued to support STEM programs with a career and technical education (CTE) focus at community colleges. And some of these programs, such as the CALWomenTech program and the STEM Equity Pipeline, focus on developing opportunities for women in STEM fields in CTE programs. Both of these programs receive funding from NSF under the Program for Research on Gender in Science and Engineering.

The two remaining programs are state-wide programs that receive broad financial support from their states.[10] Based in Washington State, the I-BEST program integrates developmental education and professional-technical curriculum in STEM

[10] Our review examined the literature on sector strategies to search for STEM programs in community colleges focused on women. Sector strategies focus on building strong regional economies by targeting specific industries and occupations and providing education and training to disadvantaged individuals (Conway 2007). Although we did not find model sector programs targeting women for STEM fields in community colleges that met the selection criteria for this report, sectoral approaches should be incorporated into strategies for expanding opportunities in STEM for low-income women and student parents.

and non-STEM fields in the 29 community and technical colleges in the state. The California Mathematics, Engineering, and Science Achievement (MESA) Community College Program (MCCP) serves students at 33 California community colleges that plan on transferring to a four-year institution to earn a baccalaureate degree in a STEM field.

The programs profiled in this report include features that support the success of low-income women and student parents in STEM fields at community colleges. All of the programs use recruitment that either targets or includes women, such as web-sites featuring successful women in STEM careers, financial incentives tied to academic success, and dual enrollment programs for local high school students that introduce students to STEM fields. Most of the programs provide financial support or connect students to sources of federal and state aid—and several offer financial incentives, grants, scholarships, paid internships, and work opportunities. Several program directors, however, emphasized that sources of financial support are often inadequate—and students sometimes drop out as a result.

"Most of the programs provide financial support or connect students to sources of federal and state aid—and several offer financial incentives, grants, scholarships, paid internships, and work opportunities. Several program directors, however, emphasized that sources of financial support are often inadequate—and students sometimes drop out as a result."

On-campus child care is offered at several of these community colleges, with Head Start and drop-in child care options available at a few. Most programs have developmental courses for students requiring remedial help; examples include integrating developmental classes into core STEM classes and offering free on-line tutoring for pre-college math courses. Academic counseling and advising is available to students at most of these programs but the intensity of assistance ranges from programs with full-time, dedicated counselors and advisors to programs where faculty and staff add these functions on to other responsibilities.

Several of these programs encourage students to pursue educational pathways to STEM careers, and several have strong partnerships between community colleges and industry. Approaches include encouraging students to earn credits in "chunks" that lead to certificates and degrees, coordinating with four-year institutions to align course requirements for STEM degrees, and working with industry to align curricula with business needs. Finally, a number of programs use curricular and instructional approaches likely to appeal to women: some focus on solving real-world, industry-based problems whereas others explicitly promote gender equity in the classroom.

RECRUITMENT STRATEGIES

Most research on recruiting women into STEM fields has focused on the baccalaureate level and above (Hill, Corbette, and St. Rose 2010). An exception is research summarized in the report, *Recruiting Women into STEM Fields: Another Look* (Cossette et al. 2010). Based on a survey, site visits, and focus groups with NSF ATE grantees, the authors identify the following best practices used by community colleges for recruiting women to STEM programs.

First, successful recruitment requires building relationships with prospective female students through activities such as peer mentoring programs, workshops led by women faculty and scientists, and visits to STEM programs at community colleges that promote active participation and discussion. Second, offering information about financial aid, child care, and other supports is important for recruiting prospective female students, as is the availability of internship and apprenticeship opportunities in STEM programs. Cossette et al. (2010) note that for women who are out of high school with jobs and family responsibilities, the availability of financial aid, child care, and other supports can be especially compelling.

"…offering information about financial aid, child care, and other supports is important for recruiting prospective female students, as is the availability of internship and apprenticeship opportunities in STEM programs."

Third, community colleges need to reach out to women who are already enrolled and taking courses at community colleges. Career and academic counseling can play a critical role in presenting STEM opportunities to women while they are still exploring majors during their first year of college. Finally, recruitment efforts targeted to women (and other underrepresented groups) in STEM fields should combine several strategies that reinforce each other. Circulating a brochure that pictures a diverse group of women in STEM fields may not be sufficient. Recruitment efforts are more likely to be successful if advertising is supplemented by personalized outreach; information about financial aid, child care, and other supports; mentoring; interactive workshops; and intensive visits to local programs (Cosette et al. 2010).

"Recruitment efforts are more likely to be successful if advertising is supplemented by personalized outreach."

Several of the programs summarized in Appendix 1 use innovative strategies to recruit women to STEM programs. The CalWomenTech Extension Services Project created customized outreach tools including posters, brochures, flyers and a website for each of the eight participating community colleges. These materials combined a focus on role models (female graduates from the technology program of interest) with program and labor market information and links to related female professional associations. The Grace Hopper Program offers financial incentives to enter computer science and related fields that include reimbursement for courses and NSF-funded scholarships. The South Carolina Advanced Technology Education Center places advertisements in women's magazines and billboards with the message "Women—do you want to make more money?" and features a brochure on its website entitled *Choose Engineering Technology for a High-Tech, High-Wage Job with a Future*. And the Regional Center for New Generation Manufacturing targets women and other underrepresented students through statewide and regional expos, scholarship opportunities, and dual enrollment programs that encourage high school students to enroll in community college and jumpstart their education in engineering and technology.

"For low-income women and student parents, locating financial support and accessible, affordable child care can make the difference between staying on track and in school—or stepping away from college to work more hours in order to make ends meet."

FINANCIAL SUPPORTS AND CHILD CARE

Many community college students face difficulties in financing their education, and those with children have pressing responsibilities that can exacerbate financial and personal challenges. For low-income women and student parents, locating financial support and acces-

sible, affordable child care can make the difference between staying on track and in school—or stepping away from college to work more hours in order to make ends meet (University of Cincinnati Women's Center 2006). This is true for women who pursue STEM fields as well as other educational paths.

FINANCIAL SUPPORTS

A recent analysis of a longitudinal study of recent college entrants concluded that financial aid has a stronger effect on completion in two-year colleges than in four-year colleges (Attewell, Heil and Reisel 2010). This finding reinforces the importance of financial aid for community college students. Even though the tuition for community colleges is considerably lower than the cost of four-year institutions, many students struggle to cover educational costs at community colleges (Choy and Bobbitt 2000). Pell Grants provide one of the principal sources of support for low-income and middle-income students to pursue postsecondary education. Both the number of students receiving Pell Grants and the size of the grants has increased in recent years. Between 1999–2000 and 2009–2010, the number of students receiving Pell Grants grew from 3.8 million to 7.7 million. In 2010, the maximum award was $5,350 (The College Board 2010).

Still, Pell Grants are inadequate for many students in community colleges. Most community college students attend school part-time. In 2003–2004, almost seven in ten community college students (69 percent) were part-time students, and more than one in four (26 percent) attended school less than half time (Horn and Nevill 2006). Compared to their full-time counterparts, part-time students receive considerably smaller grants (because grants are pro-rated), and cannot include the costs of room and board in financial need estimates. Pell Grants also do not cover the costs of developmental courses, which disproportionately affects low-income students who often require remedial help before they can enroll in college-level classes (Choitz and Widom 2003; Long 2008; McIntosh and Rouse 2009).

Pell Grants place student parents in a double-bind: responsibility for children makes it difficult for student parents to sign up for a full course-load, while the smaller award for part-time students makes it difficult to cover household and child care costs. In addition, financial aid has not been adjusted for rising tuition costs and often fails to meet the needs of low-income students with children. Carnevale (2010) reports that more than half (at least 56 percent) of adult students quality for only very small amounts of student aid and loans; almost three in ten (28 percent) of these students are parents who earn less than 200 percent of the poverty threshold for a family of four.

Several program innovations have been developed to address the financial constraints affecting low-income students attending community colleges. These include models that encourage less-than-half-time students to increase their enrollment to half time by providing resources to cover forgone wages, offer direct financial incentives for academic participation and outcomes, and provide financial aid counseling to ensure that students apply for and receive all of the aid to which they are entitled (Richburg-Hayes et al. 2011).

The Grace Hopper Program described below provides financial incentives and scholarship opportunities to encourage women's retention and success in information technology and other computer fields.

PROGRAM SNAPSHOT

Program: The Grace Hopper Scholars Program in Math and Computer Science
Location: Community College of Baltimore County
Key Feature: Financial incentives and scholarship opportunities

Funded by the NSF ATE program, the Grace Hopper Scholars Program (GHSP) is located at the Community College of Baltimore County. GHSP encourages women and other underrepresented groups to pursue careers in computer science and related fields—and students have the option to complete certificates and associate's degrees, and to transfer to four-year institutions.

Financial incentives and scholarship opportunities are important features of GHSP for female students. Students receive a $300 reimbursement upon successfully completing their first credit math course (not developmental math) or 200-level computer technology course. Full-time students in STEM fields compete for NSF-funded scholarships that can be used for tuition, fees, books, supplies, equipment, and other special needs such as transportation and child care. These sources of financial support provide important tools for recruiting and retaining women in the GHSP program although part-time students are ineligible for the NSF-funded scholarships, a factor that may contribute to their lower success rates. GHSP offers several additional programs that are important to low-income women and student parents:

"Full-time students in STEM fields compete for NSF-funded scholarships that can be used for tuition, fees, books, supplies, equipment, and other special needs such as transportation and child care."

- Availability of low-cost, on-campus child care, which accepts child care vouchers from the Maryland Department of Social Services as well as access to Kids Corner, a child care service that can be used while attending GHSP events or doing homework.
- Networking and community-building opportunities including company visits, seminars, workshops, and a summer bridge program, which promotes skill-building, bonding, and networking.
- Mentors from business or academia who are available to help students plan classes, provide insight about their careers, and direct students to other resources.
- Face-to face tutoring, and free on-line tutoring, for remedial math courses as well as the required math courses for technology degrees or certificates.

CHILD CARE

Access to affordable and quality child care services is critical for student parents to succeed in community college. A recent report released by the Institute for Women's Policy Research (IWPR), *Improving Child Care Access to Promote Postsecondary Success among Low-Income Parents*, summarized the inadequate and declining availability of child care within community colleges (Miller, Gault, and Thorman 2011).

Created by the 1998 amendments to the Higher Education Act, Child Care Access Means Parents in School (CCAMPIS) is the only federal program that provides direct aid to student parents for child care. Although community colleges disproportionately enroll low-income student parents, the funding formula for CCAMPIS favors four-year institutions. Decreased federal funding led to a drop in awards for child care programs from 341 awards in 2002–2003 to about 160 awards in 2010. Analyses conducted by IWPR show that only 5 percent of the child care needed by student parents is supplied at on-campus child care centers (Miller, Gault, and Thorman 2011).

"Analyses conducted by IWPR show that only 5 percent of the child care needed by student parents is supplied at on-campus child care centers."

Several of the programs profiled in Appendix 1 offer child care to student parents. The South Carolina Advanced Technological Education Center described below is one example.

PROGRAM SNAPSHOT

Program: The South Carolina Advanced Technological Education Center
Location: Florence-Darlington Technical College, Florence, South Carolina
Key Features: On-campus child care and Head Start program

The South Carolina Advanced Technology Education program (SC ATE) focuses on improving associate degree programs in engineering technology (ET) at the 16 two-year technical colleges in the state, while also providing technical assistance to community colleges across the nation. Founded in 1996 with support from the NSF ATE program, a central goal of SC ATE is to increase the quantity, quality, and diversity of engineering technology graduates in South Carolina. For low-income women and student parents, an attractive feature of SC ATE is the availability of child care through on-campus child care centers, which are open during the day and in the evening until 11:00 p.m. For qualified families, on-campus Head Start is another resource.

"For low-income women and student parents, an attractive feature of SC ATE is the availability of child care through on-campus child care centers, which are open during the day and in the evening until 11:00 p.m. For qualified families, on-campus Head Start is another resource."

In addition, SC ATE offers several other components that are important to low-income women and student parents:

- Broad recruitment strategies stressing the economic returns to STEM careers, including advertisements in women's magazines and a website with women's testimonials.
- A loan-to-own computer program that provides students who maintain a GPA of 3.0 or greater with a laptop computer on loan, which can become theirs upon completing an associate's degree in ET.
- Scholarships and paid internships with local companies as well as an emergency fund for books, transportation, and college fees—which provides support to students so they can stay in school when financial setbacks arise.
- An ET Core Curriculum structured around solving real-world, industry-based problems, and providing hands-on experience with technology.

DEVELOPMENTAL EDUCATION

Community colleges provide remedial and developmental education to students who lack the skills in reading, writing, or mathematics needed for college-level academics. Provasnik and Planty (2008) report that, among beginning postsecondary students in 2003–2004, about three in ten (29 percent) community college students enrolled in some remedial coursework in their first year, compared with about one in five (19 percent) students at public four-year institutions. Math was the most common remedial course taken by beginning community college students (22 percent).

A solid background in college-level math is necessary to succeed in the courses required by many STEM fields in community colleges. A study by Hagedorn and DuBray (2010) illustrates the challenges faced by many community college students in progressing from developmental math to the college-level math courses required by most STEM programs. (College-level courses are those that can be transferred to a four-year school such as college algebra, trigonometry, or calculus.)

"…only 12.6 percent of students planning to transfer to a four-year school in a STEM field could start community college at college-level math; an entry-level remedial level course, such as pre-algebra, was required by more than one-third (36 percent) of those who hoped to transfer to a four-year program in a STEM field."

Hagedorn and DuBray (2010) analyzed transcripts and questionnaire data of students participating in the Transfer and Retention of Urban Community College Students in Los Angeles Project, which consists of more than 5,000 students from the Los Angeles community college district. Their analysis found that only 12.6 percent of students planning to transfer to a four-year school in a STEM field could start community college at college-level math; an entry-level remedial level course, such as pre-algebra, was required by more than one-third (36 percent) of those who hoped to transfer to a four-year program in a STEM field (Hagedorn and DuBray 2010).

Several researchers have addressed the deficiencies in remedial and developmental education programs. Bailey (2009) reports that less than half of students enrolled

in all remedial classes are successful at completing the required remedial courses and enrolling in college-level courses. Community colleges are experimenting with different strategies to improve outcomes in remedial and developmental education. One promising approach integrates developmental education or English language instruction into occupational or academic programs (Kazis and Liebowitz 2003).

The I-BEST program in Washington State described below is a model for developmental education (Jenkins, Zeidenberg, and Kienzl 2009). I-BEST combines basic skills instruction and a professional-technical curriculum to ensure that the least prepared students—many of whom are women—acquire the education necessary to successfully compete in the labor force.

PROGRAM SNAPSHOT

Program: Integrated Basic Education and Skills Training (I-BEST)

Location: Washington State

Key Feature: Integrates developmental and professional-technical curriculum

The Integrated Basic Education and Skills Training (I-BEST) program was developed by the Washington State Board for Community and Technical Colleges (SBCTC), along with the state's 29 community and five technical colleges, to provide qualified students with quality developmental education. I-Best integrates basic skills instruction with professional technical courses in fields linked to career pathways. Targeted fields include computer and information systems, engineering, and engineering technology. I-BEST prepares students for a postsecondary credential linked to good paying jobs in high-demand fields, and positions them for additional college-level education linked to degrees.

"I-Best integrates basic skills instruction with professional technical courses in fields linked to career pathways. Targeted fields include computer and information systems, engineering, and engineering technology."

For the two-thirds of I-BEST students who are women (many of whom have dependent children), this approach provides an opportunity to jump-start their education because they can acquire occupational skills while also learning the reading, math, and writing skills necessary to succeed in college. In addition, I-BEST offers a number of other components that are important to low-income women and student parents:

- Extra academic guidance to successfully complete the I-BEST program.
- Support courses and labs to supplement content courses, along with staff advising about career paths.
- State Opportunity Grants to cover tuition, fees, books, and supplies along with student support services, such as tutoring, career advising, child care, and transportation.
- Financial support for eligible students from WorkFirst, the state's welfare reform program funded through the federal Temporary Assistance for Needy Families (TANF) block grant.

COUNSELING, ADVISING, AND ACADEMIC SUPPORTS

BACKGROUND AND RESEARCH FINDINGS

Many students enter community college with limited knowledge about what is required to attain a credential or transfer to a four-year institution (Furchtgott-Roth, Jacobson, and Mokher 2009). Some experts propose that enhanced counseling, advising, and academic supports—such as learning communities, tutors, or mentors—can improve student success in community college (Henrici 2009; Karp 2011). Although these recommendations make intuitive sense, research is limited in this area and the findings are inconclusive.

As part of the multisite Opening Doors Demonstration, MDRC undertook a rigorous study that tested the effect of counseling and advising on academic performance of low-income students in two community colleges. Lorain County Community College and Owens Community College in Ohio ran an Opening Doors Demonstration that provided enhanced counseling and advising services as well as a modest stipend to low-income students. Students in the program were assigned to a counselor, whom they met with two or more times during the semester over two semesters to discuss academic progress and challenges. Compared with regular college counselors, counselors in the Opening Doors program were assigned far fewer students. Also, participating students were eligible for a $150 stipend for two semesters. MDRC tracked students' outcomes for three years and found that a somewhat higher proportion of the program group returned to school the second semester and earned more credits compared with the control group. Also, program students had higher registration rates for the first semester after the program ended than students in the control group did. The program, however, did not have significant effects on academic outcomes after it ended (Scrivener and Coghlan 2011).

Very few studies have looked at the effect of enhanced academic supports on student outcomes in community college, although the role of learning communities has received more attention. Typically, learning communities assign a cohort of students to a pair or group of courses that are often team taught and organized around a theme. MDRC tested a learning communities program at Kingsborough Community College in Brooklyn, New York, as part of the Opening Doors Demonstration. During their first semester, groups of up to 25 freshmen took three classes together that included one developmental English class. MDRC reported that the learning communities program had a positive effect on the college experience of students, and helped them fulfill the developmental English requirements and increase the average number of credits earned. The evidence was mixed, however, regarding the effect of the program on student persistence (Scrivener and Coghlan 2011).

COUNSELING, ADVISING, AND ACADEMIC SUPPORTS FOR STEM STUDENTS

Based on the study of community college students in Los Angeles described above, Hagedorn and DuBray (2010) call for better counseling and advising to improve outcomes in developmental and core courses for students in STEM fields. The authors argue that counselors and advisors must be proactive in helping students determine and achieve their goals. If a student shows interest in a STEM field,

counselors and advisors should encourage that individual to enroll in the sequence of courses that will lead to successfully completing a certificate, award, or transfer to a four-year institution.

"If a student shows interest in a STEM field, counselors and advisors should encourage that individual to enroll in the sequence of courses that will lead to successfully completing a certificate, award, or transfer to a four-year institution.."

Because mathematics is central to success in most STEM fields, Hagedorn and DuBray (2010) recommend placing students at the appropriate mathematics level, and then supporting them to progress to the next level. They argue that it is important for counselors to identify students who are experiencing difficulty with STEM courses early on, and then provide them with tutoring or other forms of academic support. The researchers propose that community colleges may want to implement an e-mail alert system because college counselors and advisors are often overwhelmed by the number of students assigned to them. Such a system can be designed to send an e-mail alert to students that complete one level of math but fail to enroll at the next level (Hagedorn and Dubray 2010).

One small, qualitative study found that supportive counseling and positive experiences with faculty can be critical to women's successful transfer from community college into STEM baccalaureate programs (Packard et al. 2011). This study examined the experiences of 30 women using the community college pathway to baccalaureate degrees in STEM fields. Two out of three (67 percent) of the students were first-generation college students, and almost one in four (23 percent) was a racial or ethnic minority. The study found that the women who persisted in STEM majors had positive experiences with community college faculty, supportive transfer advising, and access to academic resources. Most of the women had financial and family responsibilities, but flexible employers and supportive families made it possible to attend college and succeed in demanding STEM majors.

In a paper presented at a recent summit on community colleges and STEM education convened by the National Academy of Sciences, Packard (2011) argued that different kinds of mentoring can encourage students to persist in college and within STEM fields specifically. She states: "Students are more likely to persist in STEM when they experience a combination of 1) social-emotional mentoring functions, such as encouragement and role modeling, and 2) instructional mentoring functions, including academic support, college navigation, and career coaching."

The MESA program described below provides an intensive counseling, advising, and academic support system to community college students to support their success in STEM fields at community colleges and successful transfer to four-year institutions.

PROGRAM SNAPSHOT

Program: California MESA Community College Program
Location: 33 California community colleges
Key Feature: Intensive academic counseling, advising, and academic supports

The Mathematics, Engineering, and Science Achievement (MESA) program supports academic achievement in science and math among disadvantaged students, many of whom are in California at K–12 schools, community colleges, and four-year institutions. The MESA Community College Program (MCCP) serves students at 33 California community colleges who plan on transferring to a four-year institution to earn a baccalaureate degree in a STEM field (e.g., engineering, life sciences, math and physics, computer science, and other sciences).

A key feature of MCCP is an intensive academic counseling, advising, and academic support system. Each community college has a full-time MESA director who serves as the point of contact, advocate, and mentor for program students as well as a designated academic advisor who meets regularly with MCCP students. Also, each host campus has a special center dedicated to MCCP students, which serves as the hub for studying, tutoring, and social activities. These multiple academic supports have special benefits for the 40 percent of MCCP students who are women. Because women commute to campus and often juggle competing demands from jobs and family, these supports reinforce their commitment to the program.

MCCP offers several other components that are important to the success of low-income women and student parents:

- Academic assistance from tutors, academic excellence workshops, and coursework structured in collaborative teams.
- Industry partnerships with companies such as Google, Hewlett-Packard, Boeing, General Electronic, and IBM that support students through mentorships, scholarships, summer research programs, internships, and part-time and summer jobs.
- Financial support through a Board of Governor's waiver of tuition and fees, Pell Grants, and need-based scholarships funded by NSF.
- Career planning activities through workshops and job fairs, mentorships, guest speakers, career fairs, summer research programs, internships, and industry field trips.
- Employment opportunities as MCCP peer tutors, workshop facilitators, and program aides.

EDUCATIONAL PATHWAYS

An important issue in STEM education at community colleges—especially for low-income women and student parents—is creating educational pathways toward earning credentials, awards, and degrees. A student should be able to earn credits in a STEM field that lays the basis for additional coursework and leads to credentials or transfer to a four-year institution.

Many community colleges allow students to earn and stack credits over time. Students whose work or family responsibilities require them to leave and return to college at a later point can still accumulate credits toward a credential and de-

gree (Holzer and Martinson 2008). Typically a stackable credential model uses specifically defined competencies that capture the skills and abilities required for certificates or academic degrees. Students in programs with stackable credentials can accumulate and tie together credentials that prepare them for particular occupations, allowing them to advance to more skilled, higher paying occupations (Holzer and Nightingale 2009.)

Establishing educational pathways requires coordination between courses at the certificate, associate's, and baccalaureate levels. STEM students at community colleges often encounter problems in this area. The applied courses required for an occupational certificate sometimes differ from the academic courses required for an associate's degree in a STEM field. As a result, students who have earned an occupational credential in a STEM field sometimes find that these credits cannot be applied toward earning an associate's degree in that same field (Hoffman et al. 2010).

In a similar vein, Hardy and Katsinas (2010) found that community college students sometimes learn that four-year institutions do not always count STEM credits earned at community college toward a baccalaureate degree. NSF funds a program focused on improving the alignment of STEM courses at community colleges and four-year institutions: the Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP). STEP provides funds to develop partnerships between community colleges and four-year universities that improve transfer articulation policies that increase student success (Hoffman et al. 2010).

The Regional Center for Next Generation Manufacturing (RCNGM) described below is an excellent example of a program focusing on supporting educational pathways to STEM careers. At the core of the program is a partnership between Connecticut community colleges and the Connecticut Business and Industry Association (CBIA). A survey administered by CBIA identifies industry needs for skilled, technical workers in STEM fields. RCNGM uses the survey results and guidance from industry to develop curricula and career paths in fields such as laser manufacturing, photonics, bio-manufacturing, aerospace, nanotechnology, and the manufacture of fuel cells.

PROGRAM SNAPSHOT

Program: The Regional Center for Next Generation Manufacturing
Location: 12 Connecticut community colleges
Key Feature: Stackable credits leading to STEM credential and degrees

The Regional Center for Next Generation Manufacturing (RCNGM) was founded in 2004 to address the demand for highly skilled, technical workers in the new manufacturing workplace. Funded by the NSF ATE program, RCNGM prepares students in Connecticut's 12 community colleges for STEM careers in high-demand, high-skill fields.

A key feature of RCNGM is the provision of educational pathways that allow students to earn stackable credits that lead to certificates and associate's degrees, and potential transfer to four-year institutions. The program offers students a pathway to a STEM career in Connecticut's manufacturing sector with multiple entry points: Students can start their engineering or technology coursework at any of the state's 12 community colleges and stack credits in chunks that count toward certificates, associate's degrees, or transfer to a four-year school. Articulation agreements between Connecticut's two-year colleges and four-year institutions allow students to transfer and earn a bachelor's degree in STEM fields without losing credit. This approach can be especially attractive to women who often need to enroll in college part-time and take time out from school for jobs and family commitments.

"The program offers students a pathway to a STEM career in Connecticut's manufacturing sector with multiple entry points: Students can start their engineering or technology coursework at any of the state's 12 community colleges and stack credits in chunks that count toward certificates, associate's degrees, or transfer to a four-year school."

Other program components that are likely to be particularly helpful to ensuring the success of low-income students and student parents include:

- On-campus child care at all 12 community colleges campuses with fees based on income and set on a sliding scale.
- Financial aid from scholarships, including scholarships funded by the National Aeronautics and Space Agency (NASA), and emergency funds at each community college to assist students with unanticipated costs.
- Academic advising and supports, including basic skills testing, developmental programs and English as a Second Language (ESOL) courses; tutoring (including on-line tutoring), and career planning and placement counselors.
- Specialized, industry-driven curriculum that addresses real-world problems and includes on-line courses to support students with multiple demands on their time.
- A Facebook page with chat rooms where students can communicate with each other about school projects and connect with mentors from industry and professional associations to ask questions.

CURRICULUM AND INSTRUCTION

Concern about the low number of students entering STEM fields at the baccalaureate level has led to curricular reforms focused on improving instructional materials and practices. These reforms promote greater interaction between students and faculty, improvements in technology, more teamwork, and greater application to real-world problems (Hill, Corbett and St. Rose 2010; Osborne, Miller, and Farabee-Siers, 2008). NSF reports that these changes can improve student outcomes, but universities and departments are sometimes unaware of these reforms or resist new instructional approaches (National Science Board 2010).

Two of the programs profiled in Appendix 1 have implemented innovative approaches to curriculum and instruction designed to increase the retention of students in

STEM fields at community colleges. The Regional Center for Next Generation Manufacturing developed a specialized, industry-driven curriculum that addresses real-world problems. Through a partnership with Connecticut industries, RCNGM identifies demand for skilled, technical workers in STEM fields and develops Technology Studies Curricula that prepare students for careers in these fields. Instructors are placed with advanced manufacturing companies for four-week externships in cutting-edge technologies—which prepares them to implement relevant curricula and classroom projects using real-world, hands-on design projects.

"The Regional Center for Next Generation Manufacturing developed a specialized, industry-driven curriculum that addresses real-world problems. Through a partnership with Connecticut industries, RCNGM identifies demand for skilled, technical workers in STEM fields and develops Technology Studies Curricula that prepare students for careers in these fields."

The curriculum and teaching techniques developed by the South Carolina ATE program are viewed as models for increasing the number of students who complete associate's degrees in engineering technology (ET). In the first year of study, ET students enroll in the Engineering Technology Core Curriculum (ET Core), which is structured around solving real-world, industry-based problems and providing hands-on experience with technology. To learn about the job skills required in industry, faculty visit companies in interdisciplinary teams. A classroom approach has evolved that mirrors the workplace through multi-disciplinary content, problem-based learning, just-in-time instruction, and student teams for all major classroom assignments.

PROGRAM SNAPSHOT

Program: California WomenTech Extension Services Project
Location: Eight California community colleges
Key Feature: Gender Equity in Curriculum and Instruction

With support from the NSF Program for Research on Gender in Science and Engineering, the National Institute for Women in Trades, Technology, and Sciences (IWITTS) launched the California WomenTech Extension Services Project (CalWomenTech) at eight community colleges in California. A central goal of the project is to increase the number of women who enroll and succeed in a wide range of STEM fields, including computer networking and information technology, 3D animation and video game art, and geographic information systems.

A key feature of the project is an instructional approach and curriculum that appeals to female interests and supports the development of women's skills. Examples include using classroom examples based on women's learning styles, ensuring that both women and men participate equally in labs, and increasing the number of collaborative projects. In addition, the CalWomen Tech project has other features that are important to women's success.

- Customized recruitment tools—including posters, brochures, flyers, and a website—for each campus with photographs of female graduates from the college's STEM programs along with program and labor market information.
- A leadership team made up of a broad cross-section of leaders at each college to promote institutionalization of gender equity in STEM education at each institution.
- An annual recruitment and retention plan at each college, building on what was most effective in supporting women students during the previous year.
- Training for college faculty that includes information on women's learning styles and strategies for integrating women into the STEM classroom.

Most of the attention and research on gender equity in STEM curricula and instruction has focused on the baccalaureate and graduate levels.[11] Two of the programs highlighted in Appendix 1 focus on promoting gender equity in curricula and instruction in STEM fields at community colleges. The CalWomenTech project works with eight California community colleges to implement gender equity in STEM curricula and instruction (see box above). And the STEM Equity Pipeline partners with 11 states to train education professionals in high schools and community colleges to improve gender equity in traditionally male career and technical education (CTE) programs (see box below).

PROGRAM SNAPSHOT

Program: STEM Equity Pipeline
Location: II states
Key Feature: Training and educating STEM professionals in CTE programs

The STEM Equity Pipeline (the Pipeline) is a project of the National Alliance for Partnerships in Equity Education Foundation (NAPE-EF) focused on increasing the number of girls and women in STEM programs in high schools and community colleges. With funding from the NSF Research Program on Gender in Science and Engineering, the Pipeline is working with 11 states to improve gender equity in nontraditional CTE programs in STEM-related career clusters: science, technology, engineering, and math; architecture and construction; agriculture, food, and natural resources; health science; information technology; manufacturing; and transportation, distribution, and logistics.

A key feature of the Pipeline is its focus on training and educating teachers and faculty to increase the representation of girls and women in STEM CTE programs. In each of the 11 states, the Pipeline assembles a team made up of educators, community-based organizations, and leaders of statewide professional organizations. The Pipeline works with these state teams to conduct performance gap analysis of how well STEM programs are serving women and girls, as well as an inventory and assessment of the professional development needs of teachers and faculty. Based on the findings, an implementation plan is developed that focuses on teacher and faculty professional development.

[11] See Hill, Corbett, and St. Rose (2010) and Osborne, Miller, Farabee-Siers (2008).

Other components of particular importance to low-income women and girls include:

- Training for faculty and staff focused on gender equity and nondiscrimination in STEM fields.
- Hands-on activities to engage students and connect STEM programs to the real world.
- Strong career guidance, counseling, and career exploration activities for all students, including women and girls.
- Role models and mentors to connect students to STEM careers.
- Engagement with the business community.
- Creating a positive school climate through cohort-based activities.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

Scientists and policymakers point to the community college as a critical link in the educational pathway to STEM careers for women and students who are low-income, minority, or the first in their families to enter college. This link must be bolstered if community colleges are to provide opportunities in STEM fields for large numbers of these students. College administrators, researchers, and policymakers all have an important role to play in accomplishing this goal. This final section of the report provides several recommendations for strengthening programs, conducting research, and implementing federal policies to support the expansion of STEM programs at community colleges for women and people of color, low-income students, and student parents.

"Investments in STEM education at community colleges make good economic sense: students receive the academic preparation and credentials to enter high-wage STEM careers and the nation benefits from an expanded STEM workforce to meet the needs of U.S. industry."

Some of the recommendations proposed below will require reallocation of existing resources, and others will require new funding. The current fiscal climate has placed considerable pressure on policymakers and community colleges to target funding to the most important programs and services. Investments in STEM education at community colleges make good economic sense: students receive the academic preparation and credentials to enter high-wage STEM careers and the nation benefits from an expanded STEM workforce to meet the needs of U.S. industry.

STRENGTHEN STEM PROGRAMS IN COMMUNITY COLLEGES

The programs highlighted in this report suggest a number of promising approaches for increasing the representation of low-income women and student parents in STEM fields at community colleges. It should be noted that most of these approaches, however, have not yet been tested using rigorous research methods. Nevertheless, preliminary evidence suggests that increasing the numbers of low-income women and student parents in STEM fields will depend upon implementing proactive recruitment strategies, and providing an array of programs, approaches, and support services to ensure student persistence and success.

"Successfully recruiting women and student parents into STEM programs in community colleges depends upon multiple strategies that target high school students as well as women already enrolled in community college."

ACTIVELY RECRUIT WOMEN AND STUDENT PARENTS

Successfully recruiting women and student parents into STEM programs in community colleges depends upon multiple strategies that target high school students as well as women already enrolled in community college.

- Personalize recruitment efforts and invite active participation through peer mentoring programs, hold workshops led by women faculty and scientists; and visit STEM programs at community colleges.
- Inform prospective female students about financial aid, child care, and other supports available at community colleges—including internships and work opportunities.

- Emphasize the economic benefits of high-wage, high-skill STEM fields, as well as the broader applications of STEM disciplines.
- Combine reinforcing strategies such as advertising, personalized outreach, information, mentoring, interactive workshops, and visits to STEM programs.

PROVIDE FINANCIAL SUPPORTS AND CHILD CARE SERVICES

Two important factors in supporting the success of low-income women and student parents in STEM fields at community colleges are financial support and accessible, affordable child care.

- Protect Pell Grants and broaden eligibility requirements for community college students so that part-time students qualify for more support (see discussion of federal policy below).
- Provide financial aid counseling to ensure that students apply for and receive all of the aid to which they are entitled.
- Offer financial incentives, such as payment for course completion, and scholarship opportunities to students.
- Provide subsidized on-campus child care during school and evening hours.
- Offer drop-in child care options that allow students the flexibility to attend evening and weekend activities and complete homework.

IMPROVE AND EXPAND DEVELOPMENTAL EDUCATION

Promising approaches integrate, coordinate, and align developmental education with certificate and degree-granting programs to create a seamless pathway for students in STEM fields.

- Build on the I-BEST model by integrating developmental education into introductory STEM courses so that students can acquire pre-college math skills while earning credit in their field of interest.
- Identify students who are experiencing difficulty in developmental classes and provide them with counseling, tutoring, and other forms of support.
- Use active advising and notification systems to support students to move from one level of developmental math to the next, and then on to the required science and math courses in STEM fields.

PROVIDE STRONG COUNSELING, ADVISING, AND ACADEMIC SUPPORTS

By providing counselors, advisors, and academic supports, community colleges can help low-income students and student parents earn STEM credentials and successfully transfer to four-year institutions to earn bachelor's degrees in STEM fields.

- Provide adequate funding so that counselors have a limited number of students to advise.
- Identify advisors and counselors to provide guidance and support to students at an early stage of the STEM educational process, and throughout the program of STEM study.
- Encourage students to enroll in the sequence of courses necessary to complete a STEM certificate or degree, or to transfer to a four-year institution.
- Implement early warning systems, requiring counselors to contact and offer assistance to any student who is failing or has poor grades, or who has missed a certain number of classes.
- Provide a range of academic supports including tutors, academic excellence workshops, and coursework structured in collaborative teams.

CREATE EDUCATIONAL PATHWAYS

Strong educational pathways are needed that encourage low-income students and student parents to earn credits toward STEM credentials and degrees that lay the basis for additional coursework—and result in certificates, associate's degrees, and potential transfer to four-year institutions.

- Encourage and support all students, including low-income women and student parents, to earn stackable credits that count toward certificates and degrees.
- Align the courses required for certificates, associate's degrees, and baccalaureate degrees in STEM fields.
- Develop partnerships between community colleges and four-year universities with transfer articulation policies in STEM fields.

IMPROVE CURRICULA AND INSTRUCTION

Innovations in STEM curricula and instruction should include broad reforms designed to benefit all students and strategies focused on eliminating gender stereotypes and bias in the classroom.

- Adopt innovations in STEM instruction and curricula that promote greater interaction between students and faculty, increase teamwork and hands-on activities, and provide applications to real-world problems.
- Implement ongoing gender equity and nondiscrimination training for faculty and staff.
- Use classroom examples that appeal to women's interests and learning styles, ensure that women participate equally in labs, and increase the number of collaborative projects.

CONDUCT RESEARCH ON WOMEN AND STUDENT PARENTS IN STEM FIELDS AT COMMUNITY COLLEGES

There is scant research on the experience of women and student parents in STEM programs at community colleges. Quantitative and qualitative studies are needed

to examine the factors associated with the progress of women and student parents in different STEM fields at community colleges, as well as the programmatic approaches that encourage their attainment of certificates, associate's degrees, and transfer to four-year institutions. It is important that research focus on the STEM experiences of different groups of women, including low-income women, student parents, and women of color.

Studies should focus on the experience of women and student parents in different STEM fields (e.g., information technology, biotechnology, and engineering) and different programs at the developmental, certificate, associate's, and transfer levels. Several nationally representative and longitudinal surveys conducted by federal agencies require additional analysis, including the Integrated Postsecondary Education Data System (IPEDS) and the National Postsecondary Student Aid Survey (NPSAS), collected by the U.S. Department of Education, as well as the National Survey of Recent College Graduates (NSRCG), collected by the National Science Foundation. It is also important to collect new data from surveys and case studies to allow analysis of the institutional, program, and individual factors that contribute to students' success in STEM fields at community colleges. The following research areas deserve attention:

- Analysis of the individual and institutional factors that promote recruitment, persistence, and completion of STEM courses, certificates, and degrees by different groups of women and student parents at community colleges.
- Analysis of the entry and completion trajectories of women and student parents in different STEM fields at the community college and baccalaureate levels.
- Research on the barriers to entry, retention, and success for different groups of women—including low-income women, student parents, and students of color—in different STEM fields and educational tracks (e.g., certificate, degree, and transfer) at community colleges.
- Rigorous evaluation of existing STEM programs to assess how well they serve different groups of women and student parents, and the success of these populations in completing the programs. Evaluation of new programs that include promising practices in STEM education for low-income women and student parents at community colleges.

STRENGTHEN FEDERAL POLICY FOR STEM EDUCATION IN COMMUNITY COLLEGES

Federal, state, and local policy can enhance opportunities for underrepresented students, including low-income women and student parents, to succeed in STEM fields at community colleges. Although a full consideration of these policies is beyond the scope of this report, several of the most important federal policies are addressed below: (1) financial supports for low-income students, (2) funding for child care services, (3) the Workforce Investment Act, (4) Title IX in STEM education, and (5) federal investments in STEM education.

EXPAND FINANCIAL SUPPORTS FOR LOW-INCOME STUDENTS

To succeed in STEM and other fields at community colleges, low-income students and student parents need significant financial support to cover the costs of education, as well as household and child care expenses. Strengthening several federal programs—Pell Grants, Student Support Services and Temporary Assistance for Needy Families (TANF)—would go a long way toward providing these students with the financial assistance needed to succeed in community college.

PELL GRANTS AND STUDENT SUPPORT SERVICES PROGRAM

As discussed above, Pell Grants provide critical financial resources to support low- and middle-income students to attend higher education institutions, including community colleges. Still, Pell Grants are insufficient to cover the costs of higher education for many community college students. Unfortunately, some lawmakers have threatened to cut Pell Grants from their current inadequate levels.

Another federal source of financial support for low-income students is the Student Support Services (SSS) program, funded by the U.S. Department of Education. Two-thirds of SSS participants are either disabled or first-generation college students from low-income families. The program provides important services, including financial assistance, counseling and mentoring, tutoring, and instruction in basic skills. Funding for SSS, however, is quite limited: in 2010, the program awarded less than $303 million to serve about 204,000 students (U.S. Department of Education 2011b).

Several changes are needed to better meet the financial needs of low-income students at community colleges:

- Increase the maximum Pell award amount to accurately reflect what it costs to attend school, including the costs of housing, food, and child care.
- Increase the Pell award amount for part-time students.
- Expand the SSS program to cover a larger proportion of low-income and disabled college students.

TEMPORARY ASSISTANCE TO NEEDY FAMILIES

Some low-income women receive income support to pursue postsecondary education through the Temporary Assistance to Needy Families (TANF) program, which is part of the Personal Responsibility and Work Opportunity and Reconciliation Act (PRWORA). TANF funds can assist women in earning credentials in STEM and other fields at community colleges.

Passed in 1996, PRWORA made it more difficult for low-income single mothers receiving welfare to pursue postsecondary education. In addition to imposing a lifetime limit on cash assistance of 60 months, TANF placed limits on the time allowed for training and education and required that welfare recipients work at least 20 hours per week (mandatory work hours were increased to 35 hours per week in 2002) (Jones-DeWeever and Gault 2006).

In 2008, the Department of Health and Human Services (HHS) issued regulations allowing TANF recipients to pursue postsecondary education for 12 months and to count undergraduate and graduate courses as well as on-the-job training as work activities. HHS stipulated that after 12 months, continued receipt of cash assistance was dependent on working at least 20 hours per week (Lower-Basch 2008). Given the importance of postsecondary education as an anti-poverty strategy, several changes are needed in TANF:

- Create incentives that encourage states to adopt and prioritize higher education programs for TANF recipients.
- Allow welfare participants to pursue postsecondary education for their full TANF eligibility period (rather than only for 12 months).
- Allow class and study time, as well as federal work-study programs, to count toward TANF work requirements.

INCREASE FUNDING FOR CHILD CARE SERVICES[12]

As noted above, access to affordable and quality child care services is critical for student parents to succeed in community college. The Child Care Access Means Parents in School Program (CCAMPIS) is the principal federal program that provides direct support to students for child care.[13] Most child care centers use CCAMPIS funds to provide free or reduced-cost access to services for low-income student parents. CCAMPIS funding, however, falls far short of the demand for child care among student parents: "…with the average cost of full-time care for a pre-kindergarten-aged child over $7,000 per year—costs are higher for younger children—the 2010 CCAMPIS appropriation of $16 million equates to fully funded, full-time care for about 2,300 children, or care for one-tenth of one percent of low-income student parent families" (Miller, Gault, and Thorman 2011).

In addition, flaws in the funding formula penalize low-income students at community colleges. The amount of Pell funding for students at the postsecondary institution partially determines the CCAMPIS grant. Compared to four-year institutions, Pell Grant funding at community colleges is lower because Pell Grants are pegged to tuition costs, which are lower at community colleges. Although community colleges enroll a higher proportion of student parents than four-year schools do, they receive only 38 percent as much CCAMPIS funding per parent (Miller, Gault, and Thorman 2011).

To meet the needs of low-income student parents at community colleges, many more subsidized child care slots are needed. We recommend the following changes:

- Increase CCAMPIS funding overall to provide child care funding to many more low-income students.
- Make changes in the CCAMPIS grant formula to provide funding proportionate to the number of low-income student parents served by an institution, rather than the amount of Pell funding received.

[12] This discussion of child care policies and funding is based on Miller, Gault, and Thorman 2011.

[13] Several other federal programs provide support to low-income student parents for child care. The federally funded Child Care and Development Fund (CCDF), along with matching state funds, provides child care subsidies to low-income families. In 2009, 18 percent of CCDF funds were used to support parents pursuing education and training. Although the Carl D. Perkins Act primarily supports career and technical education programs, provisions allow for funding child care and other support services. Also, some children's centers on college campuses meet the requirements to serve as Head Start centers (Miller, Gault, and Thorman 2011).

USE FUNDS FROM THE WORKFORCE INVESTMENT ACT

The Workforce Investment Act (WIA) is another federal policy that can be used to encourage low-income women and single parents to focus on STEM fields in community colleges (Hegewisch and Luyri 2010). Passed in 1998, WIA provides funding for one-stop career centers, which are overseen by workforce investment boards (WIBs). These one-step centers provide job training and other labor-market services to low-income workers (Holzer 2008).

Community colleges are central partners in WIA workforce programs. A report from the U.S. Government Accountability Office (GAO) in 2008 found that about one in ten one-stop career centers are operated solely or jointly by community colleges, and almost half of WIBs include community college presidents. In addition, many community colleges serve as eligible WIA training providers—that is, they receive funding to train students in occupational skills. With WIA funding, community colleges can counsel low-income women to pursue STEM and other high-wage fields at one-stop centers and encourage them to use their WIA-funded Individual Training Accounts (ITAs) to pursue these fields. When WIA is reauthorized, it is important to provide funding and incentives at community colleges (and other education and training providers) to prepare women for careers in STEM and other high-wage fields (Holzer and Nightingale 2009).

MONITOR AND ENFORCE TITLE IX IN STEM EDUCATION

In 1972, Congress passed Title IX of the Education Amendments to expand sex discrimination protections to students and employees at institutions receiving federal funds for educational programs or activities. The education and science agencies of the federal government award billions of dollars in grants to institutions of higher learning that provide education in STEM fields (see discussion below). Almost all postsecondary institutions, including community colleges, receive federal support from some source, including the CTE programs funded by the Carl D. Perkins Act and Pell Grants for students (Mullin 2010). These institutions are required to comply with Title IX.

The evidence suggests that discrimination and bias against women in STEM fields at postsecondary institutions is a continuing barrier to women's success (Sevo 2008). The extent of this discrimination, however, is unknown. In 2004, the U.S. Government Accountability Office (GAO) released a report, *Women's Participation in the Sciences,* which examined compliance with Title IX in math, engineering, and science among grantees funded by the U.S. Department of Education (Education), the U.S. Department of Energy (Energy), NASA, and NSF. GAO found that grantees are not required to report their investigations of Title IX sex discrimination complaints to federal agencies. Of the four agencies, only Education had conducted periodic Title IX compliance reviews to assess whether their grantees were complying with the law.

As mentioned before, the Obama Administration has established a Title IX Interagency Working Group to address strategies for ensuring compliance in

STEM programs from institutions of higher education that receive federal funding. This presents an opportunity for federal agencies to establish clear guidelines, measures, and enforcement mechanisms to ensure compliance with Title IX in STEM fields at institutions of higher learning, including community colleges. In addition, it is important that the federal government:[14]

- Look beyond the number of Title IX complaints to examine the policies and institutional factors that may lie behind the grievances.
- Provide technical assistance to institutions and programs under Title IX review to increase the number of women in STEM fields.
- Develop and implement sanctions for noncompliance, such as prohibiting an institution from competing for federal funds for a time.

EXPAND FEDERAL INVESTMENTS IN STEM EDUCATION AT COMMUNITY COLLEGES

Federal support for STEM programs in postsecondary education is bifurcated. Most of the federal funding for postsecondary STEM education comes from NSF and the National Institutes of Health (NIH) to support baccalaureate and graduate programs. The U.S. Department of Education provides funding to community colleges for career and technical education in STEM and other fields.[15]

A study by GAO (2006) found that 207 different federal STEM education programs provided nearly $3 billion in FY2004. NIH and NSF received nearly three-quarters of these funds and administered almost half of the STEM programs. Most of these federal dollars support graduate and post-doctoral fellowships, with relatively few resources going to community colleges for STEM programs. An important exception is the ATE program administered by NSF and described above.

Most of the federal funding for CTE in STEM fields is administered by the U.S. Department of Education through programs authorized by the Carl D. Perkins Act. CTE programs can be an important vehicle for low-income women and student parents to pursue STEM fields. As noted above, the Carl D. Perkins Act no longer includes a set-aside requiring funded CTE programs to serve a certain number of women and other underrepresented groups.

Several changes are needed to expand federal support for STEM education in community colleges and increase the numbers of low-income women and student parents served by these programs:

- Increase federal funding levels for the NSF ATE programs, and require these programs to report disaggregated data on the numbers of women, student parents, and students of color who begin and complete these programs.
- Designate a portion of federal funding in CTE programs funded by the U.S. Department of Education to recruit and support women in STEM programs at community colleges.
- Provide technical assistance to federally funded STEM programs at community colleges to support promising approaches to increasing the representation of women, student parents, and students of color in these programs.
- Fund pilot programs to test and evaluate innovative models for recruiting and retaining underrepresented groups—including low-income women, student parents, and students of color—in STEM fields at community colleges.

In sum, community colleges can play a vital role in providing educational pathways to STEM careers for low-income women and student parents. Much work remains to be done to increase opportunities for these groups in STEM fields at community colleges. The next step is to build on promising programs in STEM fields at community colleges while testing new approaches designed to support the success of low-income women and student parents. It is important that the design and implementation of STEM programs be guided by rigorous research focused on identifying what works in STEM education. At the same time, public policies and funding are needed to provide the support and incentives necessary to bring promising programs to scale, and to ensure that low-income women and student parents are recruited into and supported to succeed in the STEM fields that can prepare them for careers with good wages and opportunities for mobility.

Educating low-income women and student parents at community colleges for careers in STEM fields is a win-win for women and the nation. Acquiring the education to pursue STEM careers can enhance the earnings and mobility of these students, thereby strengthening the economic security of American families. At the same time, investing in low-income women and student parents can expand the number of highly skilled workers in STEM fields and help the nation to compete in the 21st century.

[14] These recommendations are adapted from Sevo 2008.

[15] Since 1994, the U.S. Department of Labor has funded a small program to train women for non-traditional occupations: The Women in Apprenticeship and Nontraditional Occupations (WANTO) program. Jointly administered by the Women's Bureau and the Employment and Training Administration's (ETA) Office of Apprenticeship, WANTO provides grants to community-based organizations that place women in apprenticeships and nontraditional occupations in a range of industries. Some of these occupations are in STEM fields. With an annual appropriation of less than $1 million per year, WANTO currently serves only about 100 women annually (U.S. Department of Labor 2010a, 2010b).

APPENDIX I

PROFILES OF STEM PROGRAMS

THE SCHOLARS PROGRAM IN MATH AND COMPUTER SCIENCE, COMMUNITY COLLEGE OF BALTIMORE COUNTY BALTIMORE, MARYLAND

The Grace Hopper Scholars Program (GHSP), located at the Community College of Baltimore County (CCBC), encourages women and other underrepresented groups to pursue careers in computer science and related fields, including general information technology, multimedia technology, computer-aided design, and computer graphics and visual communication. Students have the option to complete certificates and associate's degrees, and to transfer to four-year institutions. GHSP offers students a variety of learning experiences and support services to help them succeed, including financial incentives and scholarship advice, bridge programs, networking opportunities, career workshops, role models and mentoring, specialized tutoring services in mathematics, internships, and on-campus child care.

With support from the NSF ATE program, CCBC recruited 74 women to the GHSP between 2004 and 2008. Although the program is open to men and women, more than 90 percent of Grace Hopper Scholars (GHS) are women. Six in ten participants are enrolled part-time, one in four is enrolled full-time, and the remaining students moved between part-time and full-time status. Compared to the student body overall, a higher proportion of GHS are students of color: 39.2 percent of GHS are African American (versus 31 percent in the student body overall), 21.6 percent are Asian (versus 5 percent overall), and 2.7 percent are Hispanic (versus 2 percent overall).

Most GHS are recruited through faculty referrals (70.3 percent), although targeted mailings attract students as well. Interested applicants sign an agreement outlining program requirements and student expectations. The principal investigators note that most of the women who apply to the program are highly motivated and passionate about working with computers: "Many viewed GHSP as a stepping-stone to the next level of their career and were eager to reach that goal" (Leitherer and Tupper 2007).

Financial incentives and scholarship opportunities provide important tools for recruiting students to GHSP. Students receive a $300 reimbursement upon successfully completing their first credit math course (not developmental math) or 200-level computer technology course. From 2004 to 2008, two out of three GHS qualified for course reimbursement. In fall 2004, NSF awarded CCBC a four-year Computer Science, Engineering, and Mathematics (CSEMS) scholarship program for full-time students earning associate's degrees in Computer Information Systems/Networking, Computer Science, E-Business, Engineering, Internet and Multimedia Technology/Simulation and Digital Entertainment, and Mathematics.

The maximum annual scholarship of $3,125 could be used for tuition, fees, books, supplies, equipment, and other special needs such as transportation and dependent care. From fall 2004 through spring 2007, almost 15 percent of GHPs received a CSEMS scholarship for one semester or more. In August 2008, NSF awarded a second grant to CCBC for S-STEM scholarships of up to $10,000 a year to full-

time students in biology, chemistry, computer science, engineering, environmental science, mathematics, and physics.

GHSP supports student retention through various strategies. Networking and community-building are encouraged by requiring participants to attend at least one event a year (e.g., company visits, seminars, and workshops) as well as the annual summer bridge program. The mandatory summer bridge program promotes skill-building, bonding, and networking through hands-on computer workshops; sessions on learning styles and math anxiety; and seminars on financial aid opportunities and interviewing skills.

In a survey of 50 GHSP students, half of them stated that belonging to a group of women with similar interests and career goals was the most beneficial aspect of the program. The GHSP team organizes social events, such as pizza and movie nights, visits to four-year schools, and field trips to local businesses—and students are invited to bring their children along to these events. Only one in ten scholars, however, participated in any particular social event due to conflicts with school schedules, family obligations, and job commitments.

Support from mentors is a centerpiece of the GHSP. Each student is assigned a mentor from business or academia, and required to contact the mentor at least twice during the semester. Mentors are available to help students plan classes, provide insight about their careers, and direct students to other resources. The program tries to pair scholars with mentors from the same field but has also found that sharing common interests—such as working out at the gym or watching sports—can strengthen the bond between mentor and mentee. Most of the mentors complete a mentor training session and guidelines for mentor/mentee interactions are posted on the GHSP website.

The GHSP team advises students with course selection, scheduling, and tutoring services. Tutoring is especially important because many students lack the math skills to enter the core math courses required in computer-related fields. GHSP has augmented the free face-to-face tutoring available to all students at CCBC by coordinating with the tutoring center to establish a free online tutoring site for each remedial math course and required math course for technology degrees or certificates. This approach has proven especially helpful to students whose schedules interfere with coming on campus for tutoring help. In addition, faculty volunteers tutor students in math courses beyond calculus.

As a GHS, students have access to multiple career planning resources. The GHSP team provides career counseling to students throughout their time in the program, mentors are available to speak about their professional experiences, and the summer bridge program includes career panels and round tables led by female role models. Students are encouraged to network with professionals during social events and on-site company visits, and the GHSP team assists students with internship placements. In combination, these activities help to build women's confidence that they can succeed in STEM fields.

Another important source of support for GHS is on campus child care. CCBC provides low-cost child care to students, including those of GHS, through its Children's Learning Center. The Center accepts child care vouchers from the Maryland Department of Social Services. Scholars also have access to Kids Corner, a child care service that can be used while attending GHSP events or doing homework.

Data collected from 2004–2008 found that a smaller percentage of students enrolled in the GHSP dropped out of school (16 percent) compared with CCBC students overall (56 percent). Part-time students, who make up most GHS, however, had poorer outcomes than full-time students in the program. As of summer 2008, full-time participants were almost five times more likely to have received an associate's degree or certificate (39 percent for full-time students versus 8 percent for part-time students), and they were twice as likely to have received a bachelor's degree (6 percent versus 3 percent). Most troubling was the fact that part-time scholars were twice as likely to have dropped out of school (22 percent) as full-time scholars (11 percent) (Tupper et al. 2010).

Preliminary evidence from a recent survey of GHSP students suggest that the leading cause of dropping out of school is work and family commitments (Tupper et al. 2010). Survey data also revealed that part-time scholars found it difficult to attend events outside of school, and wished that more scholarships were available for part-time students. The fact that the NSF-funded scholarships can be awarded only to full-time students excludes most scholars who attend school part-time. The principal investigators of the GHSP state that going forward, "more emphasis needs to be placed on the specific circumstances of part-time students" (Ibid).

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THE SOUTH CAROLINA ADVANCED TECHNOLOGICAL EDUCATION CENTER, FLORENCE-DARLINGTON TECHNICAL COLLEGE FLORENCE, SOUTH CAROLINA

Founded in 1996 with support from the NSF ATE program, the South Carolina Advanced Technology Education program (SC ATE) initially focused on improving associate degree programs in engineering technology (ET) at two-year colleges in the state and across the nation. For the first seven years, SC ATE worked with the 16 technical colleges in the state to increase the quantity, quality, and diversity of engineering technology graduates in South Carolina. In 2002, the SC ATE was selected by NSF to become one of 39 centers providing best practices and materials on engineering technology (ET) education to colleges across the country. The national SC ATE Center now includes both ET and other emerging fields of study in advanced technological education with a special emphasis on faculty development and program improvement.

This program profile focuses on SC ATE's work with technical colleges in South Carolina. Although the model is designed for all students, several of its features

target or benefit women. To recruit students, SC ATE disseminates marketing materials to corporate leaders, the media, students, and parents. Advertisements are placed in women's magazines, such as *South Carolina Woman* and *She*, and billboard ads entice women with messages such as "Women—do you want to make more money?" Local newspapers, the college catalogue, and the handbook highlight SC ATE events including the *Technical Career Exploration Fair* and a *Tea for Two* party with door prizes, workshops, and campus tours (Cossette et al. 2010).

In addition, the website for SC ATE features information about the higher earnings and occupational growth rates (and lower unemployment rates) associated with careers in ET. A second website targeted to women posts a brochure entitled, *Choose Engineering Technology for a High-Tech, High-Wage Job with a Future*, with testimonials from women about the benefits of the program along with salary information for engineering fields. This website also links to a music video featuring women in ET, a women's technician club, and a bookmark for women in technology.

SC ATE reaches out to high schools with its Career Ambassador Program. Current students speak with prospective students in high schools and other settings about the educational opportunities available through SC ATE and career options with an associate's degree in ET. Each ambassador receives a $100 stipend per semester of service.

Scholarships and paid internships are important for recruiting and retaining students in the SC ATE program. The Tech Stars Scholarship Program, funded by a grant from NSF, is available for full-time students seeking an associate's degree in ET, industrial/manufacturing technologies, or computer technology. Awards typically cover tuition, books, computer technology certification fees, and loan-to-own laptop computers for these five-semester programs. Because Federal Pell Grants typically have not provided financial support for summer enrollment, Tech Stars scholarships have been particularly beneficial for covering student expenses during the summer—allowing many students to graduate on time.

A popular feature of the Tech Stars Program is the loan-to-own laptop option. Tech Stars scholars who complete one or more semesters at FDTC in a designated associate's degree program with a 3.0 or greater GPA are eligible to receive a laptop computer on loan, which can become theirs upon completion of an associate's degree in ET. Although this incentive has led to higher enrollments and increased numbers of full-time students in ET fields, the laptops have been particularly important for female students who are parents. One parent told program staff, "I no longer have to arrange child care on weekends so I can come to college to use their computers. I can stay home and use the computer at home." Also, the laptop saves time and money on transportation because many students live an hour or more from these rural campuses.

Students also can apply for scholarships and internships through a partnership with a consortium of industries. Accepted students receive scholarships for tuition and books, and work at least 20 hours a week at a paid internship with one of the 20 company sponsors in the Industry Consortia. Between 2000 and 2010, this Scholars Program placed 107 interns in South Carolina manufacturing, energy, construction, engineering, and IT firms. Ninety-eight of these scholars have graduated and moved on to careers in ET, and seven are currently enrolled in college and placed in internships.

The innovative curriculum and teaching techniques developed by SC ATE are seen as a model for increasing the number of students who enter and complete associate's degrees in ET. The approach combines a transition program, Technology Gateway (TG), with a core ET curriculum. TG is a transitional, pre-engineering program that prepares students to enter majors in ET. Available to high school students as a dual-credit program, TG courses are also offered at the community colleges as a one-semester curriculum that includes a career exploration module along with instruction in mathematics. In addition, TG is showing promise as an effective dropout prevention strategy with both secondary and post-secondary students.

The Engineering Technology Core Curriculum (ET Core) provides the general education component of the first year of study for ET majors. The curriculum is structured around solving real-world, industry-based problems, and provides hands-on experience with technology. The faculty is encouraged to visit companies in interdisciplinary teams to learn about the requirements of today's workplace. What has evolved is a classroom approach that models the workplace through multidisciplinary content, problem-based learning, just-in-time instruction, and the use of student teams to complete all major classroom assignments. Upon completion of the ET Core, students matriculate into the second year of courses to earn an associate's degree in ET.

Although the curriculum is designed to benefit all students, an independent evaluation conducted by the Academy for Educational Development (AED) stated that this approach might serve women and underrepresented minorities particularly well:

> The extra attention afforded to ATE students, through student teamwork and the presence of multiple faculty members, strengthens the connections of women and minorities to classes typically dominated by Caucasian men. Through the application of multiple intelligences and learning styles theory, ATE lessons are designed to engage students from a variety of backgrounds. Integrating engineering courses with English and communications—subjects in which women typically outscore men—may engage more women in technical studies (Güemes-Castorena and Bucci 2002, p. 58).

Two important sources of support for single parents at Florence-Darlington Technical College (FDTC) are child care and emergency assistance. FDTC offers on-campus child care for students, faculty, and staff both during the day and in the evening until 11:00 p.m. There is also a Head Start program on-site for qualified children and families. Children, however, must be age two or older to attend these programs, so those with infants must find other child care.

Help is also available for students who require emergency assistance. Students can apply to an emergency fund for assistance with books, transportation, and college fees. Program staff explained that what might seem like a small financial setback for someone with more income can lead one of their students to drop out of school. Having an emergency fund to assist a student who needs to fix her car (in order to get to class) or pay tuition and fees before the Pell check arrives provides peace of mind to student and staff alike.

Since 1998, some data have been collected on enrollment, diversity, and graduation rates at FDTC. Overall enrollment doubled at the college between 1998 and 2004,

while African American enrollment increased from 15 percent to 39 percent of program students. Graduation rates increased from 12 percent to more than 40 percent during this period, and the average time a student takes to graduate with an associate's degree in ET declined from 3.8 years to 2.2 years. Limited data are available on women's enrollment in SC ATE programs. The program reports that in 2009, women made up 27 percent of the students who took at least one-ATE supported course.

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INTEGRATED BASIC EDUCATION AND SKILLS TRAINING (I-BEST) WASHINGTON STATE

Many low-income women and student parents require developmental and remedial education to learn basic skills and prepare them for college-level coursework. Unfortunately, only a small proportion of these students ever progress beyond the developmental level. The Integrated Basic Education and Skills Training (I-BEST)[16] program is an innovative approach developed by the Washington State Board for Community and Technical Colleges (SBCTC) along with the state's 29 community and five technical colleges. This model integrates basic skills and professional-technical instruction so that students who need extra help can start their college-level courses at the same time. The federal government has singled out I-BEST as a promising program for TANF parents transitioning from welfare to work.

To receive state support, colleges must demonstrate that their I-BEST program is based on a career pathway made up of integrated courses in professional-technical fields that prepare students for postsecondary credentials, high-demand jobs, and additional college-level education linked to degrees. Almost nine in ten (88 percent) I-BEST students are enrolled in health care, manufacturing, education, and business fields—and 7 percent are enrolled in STEM fields including computer and information systems, engineering, and engineering technology. Potential wages for I-BEST completers are the highest in language translation ($20 an hour), protective services ($17.46 an hour) and STEM ($17.13 an hour), while wages are the lowest in education ($9.62 an hour).

In 2009, I-BEST served about 2,795 students in more than 140 approved programs in the state. Data from the academic years 2006–2007 and 2007–2008 show that two-thirds of the students are women. Two out of three students are enrolled full-time, and their average age is 32. The student population in I-BEST is quite diverse: almost one in five (18 percent) is Hispanic, one in ten is African American, and one in ten is Asian/Pacific Islander. Many I-BEST students have dependents: more than one in five (21 percent) is single with a dependent and almost one in four (24 percent) is married with a dependent. Seven percent of I-BEST students are disabled. Three out of four I-BEST students intend to pursue vocational training and almost 8 percent plan to pursue an academic track. Also, almost six in ten I-BEST students (58 percent) are in the lowest quintile for socioeconomic status.

Washington State requires that students enrolled in I-BEST score below a certain cutoff on a standardized basic skills assessment. Most I-BEST students are recruited from the basic skills courses at community colleges, although outreach to businesses, community organizations, and one-stop career centers is also important. Recruiters use flyers, brochures, and presentations to educate students about the benefits of the program. About half the colleges have designated an I-BEST coordinator to recruit students and oversee registration and advising.

Integrating basic skills instruction and professional-technical curriculum is what distinguishes I-BEST from other basic skills programs. This approach allows students to learn occupational skills while also mastering essential components of reading, math, and writing. Most of the programs require three quarters or less to complete, and about half take two quarters or less. Classes are team-taught by two instructors who are required to be in the classroom at least half the time.

Students served by I-BEST require extra academic guidance and career assistance in order to successfully complete the program. To supplement content courses, most I-BEST programs offer support courses or labs, as well as career advice from staff. Across the community colleges, the extent of support services differs. About one-third of the colleges appoint one person for students to contact; on most campuses, I-BEST faculty and staff with other responsibilities provide support to students.

The cost of tuition is a barrier to I-BEST enrollment for many students. Compared with basic skills classes where students pay only a nominal fee ($25), the tuition for I-BEST courses is the same as any other college-level course (and students receive college credit for these courses). Still, many low-income students cannot afford the tuition for I-BEST.

In 2006–2007, many I-BEST students received financial aid from a Pell Grant, a State Need Grant (which serves the state's lowest income students), or an Opportunity Grant. Almost one in three I-BEST students was awarded a state Opportunity Grant to cover tuition, fees, and a maximum of $1,000 per academic year for books and supplies. Opportunity grants also cover student support services, such as tutoring, career advising, child care, and transportation.

[16] I-BEST is unique among the programs featured here because of the strong evaluation research associated with the program. Most of the information and data in this program summary are drawn from two reports prepared by researchers at the Community College Research Center, Teachers College, Columbia University. See Jenkins, Zeidenberg and Kienzl (2009) and Wachen, Jenkins, and Van Noy (2010).

In addition, almost four in ten (37 percent) I-BEST students received support from WorkFirst, the state's welfare reform program funded through the federal TANF block grant. Despite these sources of financial aid, many I-BEST students do not receive any type of support, and administrators note that recruitment to the program suffers as a result.

An evaluation conducted by the Community College Research Center found that I-BEST students did better than other basic skills students on a number of outcomes. Jenkins, Zeidenberg, and Kienzl (2009) compared I-BEST students to a group of matched, non-participants with similar characteristics over a two-year tracking period. The study estimated that I-BEST students earned 52 quarter-term college credits while the matched comparison group earned 34 quarter-term credits. Also, the study estimated that the probability that I-BEST students would persist into the second year was 78 percent, while that of the matched group was 61 percent. The most striking finding was that I-BEST students were almost four times more likely to earn an occupational certificate compared with the matched group (55 percent versus 15 percent).

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CALIFORNIA MESA COMMUNITY COLLEGE PROGRAM
CALIFORNIA

The Mathematics, Engineering, and Science Achievement Program (MESA) supports academic achievement in STEM fields among low-income and minority students in California at K–12 schools, community colleges, and four-year institutions. Founded in 1970, MESA's central goal is to increase the number of educationally disadvantaged students who achieve educational success in STEM fields, and go on to math-based careers. MESA is funded by the state legislature, corporate contributions, and grants.

Although MESA is administered by the University of California, the program is a partnership that involves California State Universities, California Community Colleges, the California Department of Education, and the Association of Independent Colleges and Universities—as well as individual schools, school districts, and community groups. MESA is also supported by industry. MESA has been recognized as one of the most innovative public programs in the nation by Innovations in American Government, a project of the Council for Excellence in Government supported by the Ford Foundation. The program is also a winner of the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring.

The MESA Community College Program (MCCP) provides academic and support services to educationally disadvantaged students majoring in engineering and other STEM fields. All students in MCCP must plan to transfer to a four-year institution in order to earn a baccalaureate degree in a STEM field. In academic year 2009–2010, MCCP programs supported students in 29 percent of all community colleges in the state. These 33 community colleges provide a wide array of academic, career, and social supports to help students complete their STEM education and transfer as STEM majors to four-year colleges and universities. In 2010, engineering was the most common major (38 percent) among MCCP students, followed by life sciences (24 percent), other sciences (11 percent), math and physics (8 percent), and computer science (4 percent).

Each MCCP program at a community college recruits between 100 and 125 students. Overall, there were 3,694 students in the program in 2010, 40 percent of whom were women. Minority recruitment is also strong: in 2010, 55 percent of the students were Latino, 10 percent were Asian American, 8 percent were African American, and 2 percent were Native American.

Most of the students are low-income and the first in their families to attend college—and the majority come from low-performing schools with few resources. Typically, MCCP students work at jobs for approximately 20 hours per week, and many are English language learners. Academic deficiencies are common and MCCP students often enter community college at a math level below Algebra I.

Recruiting MCCP students focuses on those who have the ability to succeed in STEM fields, but need support to develop their skills. Recruitment efforts include regular informational meetings with the MCCP director at each community college, STEM faculty, campus outreach, and student services. Accepted students sign a contract stipulating their commitment to participating in program activities, meeting regularly with the MESA director and advisor, and maintaining the required GPA.

MCCP encourages student success though intensive academic support and student-focused services including academic advising and workshops, a designated student study center, and professional development activities. Each community college has a full-time MESA director who serves as the point of contact, advocate, and mentor for program students. Several directors have a master's degree; nearly one in three has a Ph.D. and more than half of the directors are women. The counseling department at each college is required to designate an academic advisor who meets with students at the start of the program to develop a three-year student educational plan.

MCCP students are enrolled as a group in the same core math and science classes where they learn how to successfully master complex technical ideas and principles by working in collaborative teams. For extra assistance in major courses—such as chemistry, mathematics, and physics—students work with tutors and participate in

academic excellence workshops. Throughout the program, MESA advisors track students' progress and meet with them periodically to ensure that students are on track for transfer to a four-year institution. Assistance with the transfer process is provided through academic counseling, visits to four-year institutions, and workshops.

The student study center is essential to students' success in MCCP. Each host campus is required to provide a center dedicated to MCCP students. As the hub for study and special activities, the center hosts tutoring sessions in math and science courses and offers book and equipment loans, a computer lab, and a lounge area and lockers for students. Equally important, the center serves as a gathering place for students in MCCP to socialize and support each other. By serving as a focal point for student activities, the center reinforces their identification with and commitment to the program.

MCCP students have access to career planning activities both on and off campus. On campus, students participate in academic and professional workshops, and student organizations that provide mentors, guest speakers, career fairs, and industry field trips. Workshops and mock job fairs help students to develop their resume writing and interviewing skills.

Off campus, students are exposed to different math, engineering, and science careers through industry partnerships with companies such as Google, Hewlett-Packard, Boeing, General Electronic, IBM, Motorola, Intel, NASA Ames Research Center, and Texas Instruments. Representatives from these companies, several of whom are MESA alumni themselves, serve on advisory boards and support students through mentorships, scholarships, summer research programs, internships, and part-time and summer jobs.

Dr. Oscar F. Porter, executive director of MESA, underscored the importance of providing an extensive support system to ensure student success in MCCP:

> Many of the students enrolled in our MESA program are the first in their families to attend college. Given the rigor of the course requirements and the lack of guidance from previous familial experience, the college experience for science majors can seem like an impossible hurdle. However, the strong support system that emerges from the MESA community has proven to empower students. The MESA program helps students develop an educational foundation, determine which educational goals are appropriate for their own interests and abilities, and take the necessary steps to attain those goals. The MESA community college program provides a supportive community that assures students that their goals can be reached by providing a mechanism specific to community college science majors that assists in retaining students who would otherwise not be successful in STEM majors.

Although MCCP targets all disadvantaged students, the model of providing multiple academic and social supports has special benefits for women. In particular, the center provides female students with a place to congregate with their peers and develop a sense of community. At this central gathering place, women study and mingle with other students, identify resources, attend faculty office hours, receive help from tutors and academic excellence workshops, and use computers to complete homework and projects. Students can drop by the office of the MCCP director or advisor, which are located at the center or nearby. Because women commute to campus and often juggle competing demands from jobs and family, the center reinforces their commitment to the program, which is critical to student achievement.

The support and guidance provided by MCCP staff contributes to the success of female and male students alike. One of the advantages of having dedicated staff for MCCP on each community college campus is their ability to get to know each student and their needs. The director and advisor make it a priority to develop informal relationships with personnel across the campus so that they can direct students to assistance with financial, health, or other problems.

Financial support is critical to the retention of MCCP students. Many students receive the Board of Governor's waiver from paying tuition and fees, and most qualify for Pell Grants to cover books, transportation, and other living expenses. Students can also apply for a need-based scholarship funded by NSF for students who plan to transfer and attend a California four-year institution. This scholarship offers up to $12,500 over one to three years. In addition, MCCP employs many students as peer tutors, workshop facilitators, and program aides. Not only does this supplement students' income, but employment with MCCP encourages students' understanding of how to be successful in a STEM major.

MCCP has a strong track record in transferring students to four-year institutions in STEM fields: in academic year 2009–2010, 100 percent of MESA transfer students entered colleges and universities as math or science majors. Forty-five percent transferred to the University of California; 45 percent transferred to the California State University, and 10 percent transferred to independent California universities and colleges, out-of-state universities and colleges, and other institutions. California MESA is the model for similar programs in over a dozen other states.

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REGIONAL CENTER FOR NEXT GENERATION MANUFACTURING CONNECTICUT COMMUNITY COLLEGES COLLEGE OF TECHNOLOGY HARTFORD, CONNECTICUT

The Regional Center for Next Generation Manufacturing (RCNGM) was founded in 2004 to address the demand for high-skill, technical workers in Connecticut's new manufacturing workplace. RCNGM is funded by the NSF ATE program and directed by the Connecticut College of Technology (COT), a virtual organization

serving the 12 community colleges in the state. By grounding its curriculum in the workforce needs of Connecticut industries, COT prepares students for STEM careers in high-demand, high-skilled fields such as green technology, lasers and photonics, precision machining, and alternative energy. Students can earn credits in chunks that lead to certificates and associate's degrees, and transfer to four-year institutions. For women who are part-time students with work and family responsibilities, this approach supports their progress in moving through the STEM educational pipeline.

Students are recruited to the technology and engineering programs offered by COT through a number of strategies. A comprehensive marketing campaign reaches out to underrepresented students through Saturday programs along with statewide and regional expos. The RCNGM website features upcoming events, videos spotlighting distinguished professionals in engineering and technical fields, and scholarship opportunities for students. To educate students about career opportunities in Connecticut's manufacturing sector, COT distributes more than 4,000 *Manufacture Your Future* DVDs (along with Teachers' Guides). Also, high school students are encouraged to get a head start on their education through dual enrollment programs in engineering and technology at nearby community colleges.

At the core of COT's approach is a specialized, industry-driven curriculum that addresses real-world problems developed through a partnership with the Connecticut Business and Industry Association (CBIA). A survey administered by CBIA identifies the current needs for skilled, technical workers in science, technology, and engineering fields. Based on these survey results and other input from industry, COT develops Technology Studies Curricula to prepare students for careers in fields such as laser manufacturing, photonics, bio-manufacturing, aerospace, nanotechnology, and the manufacture of fuel cells. A partnership with CBIA has resulted in placing 130 instructors with advanced manufacturing companies for four-week externships in cutting-edge technologies. These experiences prepare faculty to implement innovative curricula and classroom projects using real-world, hands-on design projects.

COT offers students a pathway to a STEM career in Connecticut's manufacturing sector with multiple entry points. Students can start their engineering or technology coursework at any of the state's 12 community colleges and earn credits in chunks that count toward credentials or associate's degrees. Articulation agreements between Connecticut's two-year colleges and four-year institutions allow students to continue their education in STEM fields without losing credit.

For example, students can earn a one-year certificate or associate's degree in manufacturing machine technology at Middlesex Community College. Those who wish to go on to a four-year institution for a baccalaureate degree can seamlessly transfer their community college credits to designated Connecticut colleges and universities. Karen Wosczyna-Birch, Director of RCNGM, noted that this approach can be especially attractive to women whose jobs and family responsibilities often lead to part-time enrollment in school and stopping out from time to time. As women earn credits in a technology or engineering field that can be applied toward an associate's degree, their self-confidence increases and they are able to take the next step.

In addition to organizing the recruitment and curricula for the Technology Studies Program, COT coordinates the technology programs across the community colleges in Connecticut. COT has established a site coordinators' group with representatives from the 12 community colleges and high schools with students in the program. Monthly meetings held during the academic year provide an opportunity for coordinators to learn about new curricula and share best practices and challenges.

Specific academic supports and advising for students in technology and engineering fields are offered at each community college. Each college provides basic skills testing to ensure appropriate class placement, developmental programs to provide the foundation for successful college-level work, English as a Second Language (ESL) courses to help non-English speakers succeed at college, first-year experience programs to support students' adjustment to college life, and tutoring (including on-line tutoring) and individualized instruction to support students with special needs. Also, career planning and placement counselors assist students with future job and career opportunities.

Financial aid and support is available through various sources. COT provides scholarship funds to the community colleges, which then identify eligible students for awards. Some of these scholarship funds come from NASA grants to Connecticut for STEM education, a portion of which supports students in STEM fields at community colleges. Also, each community college has its own foundation to assist students with emergency needs, such as the cost of books.

The Director of RCNGM described activities that support women's achievement in technology and engineering fields. Women make up the majority of most participants in the *Life Support and Sustainable Living* (LSSL) initiative, which pairs community college students with peers from four-year institutions to work on collaborative, team projects. One team developed a project for the Children's Medical Center using math and engineering skills to design a monitor for premature infants.

LSSL encourages peer mentoring between the community college students whose training is more practical and the four-year students whose training is more theoretical. A professional skills module helps students develop time management skills and a better understanding of their motivations and behaviors in interactions with team members. Students receive college credit toward degree completion as well as stipends, which are especially important to female students who often have children to support.

The Regional Center also develops opportunities for mentoring and networking for female students in engineering and technology. Through connections with local chapters of professional associations such as the Society of Women Engineers, guest scientists and engineers are invited to address students at lunch and learn seminars. Every effort is made to identify speakers with similar backgrounds to current students. One featured speaker was a teen mother who started her education at a community college and now works as an engineer at Pratt and Whitney. Interactions with such role models reinforce the belief that female students can succeed in STEM fields.

COT encourages female students in STEM programs across the 12 community colleges to network. This is not always easy when there are only a few female students in some STEM classes. To bridge the isolation among women students,

COT created a Facebook page for the center and collaborator sites, which enables students to communicate with each other about school projects and connect with mentors from industry and professional associations to ask questions.

On-line courses at these community colleges support students with multiple demands on their time. According to the Director of RCNGM, the average student in the Connecticut community college system is 27 or 28 years old, has a job, and often has children as well. Taking online courses allows women with busy schedules to complete course work during chunks of time that work for them. Even laboratory courses are increasingly offered on-line, sometimes in a blended or hybrid format where some of the assignments are completed on-line but students come to campus for labs that require hands-on learning.

Finally, the availability of on-campus child care at all 12 community colleges campuses is an important source of support for student parents in technology studies. One of the reasons that these community colleges provide child care is that the system offers an associate's degree in early childhood education. Eligibility for child care slots is based on income with fees set on a sliding scale. Ms. Wosczyna-Birch reported that some of the women enrolled in the COT programs depend on these child care centers.

COT's multifaceted approach to supporting students to pursue careers in advanced manufacturing has led to increased enrollments in technology and engineering programs at Connecticut's community colleges. Between 2004 and 2009, the number of students in these programs increased from 2,865 to 3,913. During this five-year period, women's enrollment in STEM fields at community colleges in Connecticut increased from 540 to 630 while the number of Hispanic students increased from 666 to 944 and the number of African American students increased from 310 to 407.

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CALIFORNIA WOMENTECH EXTENSION SERVICES PROJECT ALAMEDA, CALIFORNIA

In April 2006, the National Institute for Women in Trades, Technology, and Sciences (IWITTS) was awarded a $2 million, five-year grant from the NSF Program for Research on Gender in Science and Engineering. Founded in 1994, the mission of IWITTS is to help educators across the country close the gender gap for women and girls in technology. The organization's website states: "Women and girls of working families deserve entrée to the jobs of the future—green jobs, biotechnology, medical information technology, and construction all provide a pathway out of pink-collar poverty for everyday working women."

The purpose of the NSF grant is to implement the California WomenTech Extension Services Project (CalWomenTech) at eight community colleges in the state. The goals of the CalWomenTech project are to (1) increase the number of women enrolled and retained in STEM fields at the eight community colleges, (2) institutionalize gender equity strategies in each participating college to ensure that successful recruitment and retention strategies are employed beyond the life of the project, and (3) illustrate to the California and national community college system that STEM gender equity strategies increase recruitment and retention of women in STEM fields.

At the outset, each of the eight colleges was invited to identify one or two technology programs where women were underrepresented. Colleges joined the CalWomenTech Project in two phases: cohort one started in May 2007 followed by cohort two in January 2008. The community colleges and their technology programs are listed below:

COHORT ONE

- Cañada College: 3D Animation and Video Game Art Program
- City College of San Francisco: Computer Networking and Information Technology
- El Camino College: Heating, Ventilation, Air Conditioning and Refrigeration, Welding, and Electronics
- San Diego Mesa College: Geographic Information Systems

COHORT TWO

- Evergreen Valley College: Automotive Technology Program
- Irvine Valley College: Electronic Technology Program
- Las Positas College: Automotive and Welding Programs
- San Jose City College: Facilities Maintenance Technology

IWITTS has provided each college with training on recruitment and retention strategies, and worked with them to create a recruitment plan. These recruitment plans have been updated and revised annually to focus on the most effective strategies. To assist colleges in their recruitment efforts, IWITTS created customized outreach tools for each campus. Schools provided photographs of female graduates from their technology programs to IWITTS, which incorporated these role models into posters, brochures, flyers, and a website. Each website featured a role model from the technology program of interest along with program information, labor market information, and links to women in technology associations. Having these recruitment tools in hand allowed the community colleges to spend time and resources on classroom and support strategies instead of graphic/web design and marketing materials. IWITTS has since assembled these customizable templates into an outreach kit, which is made available to educators across the country.

IWITTS believes that involvement of a broad cross-section of leaders will help to ensure institutionalization of the program at the eight community colleges once

NSF funding is no longer available. Each college has established a leadership team made up of a key leader and co-leader, and team members drawn from across the campus community. Typically, the leadership team includes the dean and chairs of targeted programs, instructors in STEM fields, the recruitment and outreach director, the public information officer, and directors of counseling and tutoring programs. It is also recommended that these teams enlist the coordinator of the women's center or equity program along with representatives from feeder high schools or job training programs.

The leadership team at each college creates an annual recruitment and retention plan building on what was most effective during the previous year. The primary focus of the retention strategies is creating a class room environment and curriculum that appeals to female interests and supports the development of women's skills. Retention training is provided to college faculty to learn about women's learning styles and strategies for integrating women into the classroom.

College instructors then apply the training to restructuring their curriculum and classroom environment to be more inclusive. Examples of changes made by faculty include using classroom examples that appeal to female interests and learning styles, ensuring that both women and men participate equally in labs, and increasing the number of collaborative projects. According to IWITTS leadership, women students benefit from retention strategies focused on the classroom because work and family commitments often prevent them from attending activities outside of school.

IWITTS provides ongoing training and technical support to the eight colleges in a variety of ways. Colleges receive resources on proven practices in recruiting and retaining women in technology fields along with off-the-shelf tools for students such as CDs and workbooks on spatial reasoning and math skills. (These resources are available to the general public as well.) Other forms of assistance include strategic plan development, monthly coaching, phone conference meetings, annual college site visits for additional training and revision of strategic plans, and facilitation of peer-mentoring among colleges on project strategies.

An external evaluator, Evaluation & Research Associates (ERA), is measuring project outcomes and providing colleges with results to use for program improvement. For this first cohort of community colleges, evaluations have been completed on the first two and a half years of the program. For the second cohort, evaluations have been completed for the first 18 to 24 months of the program. Data show an increase in female enrollment in STEM programs in six of the eight colleges, with the greatest increases occurring at San Diego Mesa College, City College of San Francisco, and Las Positas College with average annual increases of 8.7 percent, 7.6 percent, and 8.6 percent respectively.

An unanticipated finding was the increase in retention for both female and male students in the targeted STEM programs at several community colleges. The two colleges with the largest increases in women's retention were Evergreen Valley College (which increased women's retention from 57 percent to 100 percent in nine months) and San Diego Mesa College (which increased women's retention from 81 percent to 100 percent in 15 months). Male retention increased by 20 percent at these two colleges during these periods. IWITTS attributes this positive outcome to the focus on classroom climate and instructional practices—approaches that benefit both women and men.

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STEM EQUITY PIPELINE COCHRANVILLE, PENNSYLVANIA

The STEM Equity Pipeline (the Pipeline) is a project of the National Alliance for Partnerships in Equity Education Foundation (NAPE-EF) focused on increasing the number of girls and women in STEM programs in high schools and community colleges. With funding from the NSF Research on Gender in Science and Engineering Program, the Pipeline is working with 11 states to train education professionals in high schools and community colleges.

The goal of this training is to improve gender equity in nontraditional career and technical education (CTE) programs funded by the Carl D. Perkins Act of 2006. Nontraditional programs are defined as those that prepare students for careers in fields where one gender constitutes less than 25 percent of total employment in the field.

The Pipeline focuses on nontraditional careers in the following STEM-related career clusters: science, technology, engineering, and math; architecture and construction; agriculture, food and natural resources; health science; information technology; manufacturing; and transportation, distribution, and logistics.

In each of the 11 states, the Pipeline works with the leadership of the CTE to assemble a state team made up of representatives from several sectors: education professionals providing technical assistance, professional development and education to high school and community college administrators, faculty, and staff; community-based organizations serving women and girls in the state; and leaders of statewide professional organizations committed to improving girls' and women's access to STEM education in secondary and postsecondary institutions. The Pipeline works with each state team to:

- Provide project evaluators with Perkins Act accountability data, which is used to conduct performance gap analysis on the representation of women and girls in STEM-related programs of study at the secondary and community college level.
- Conduct an inventory and assessment of the professional development needs of teachers and faculty to improve gender equity in STEM-related programs of study in high schools and community colleges.
- Develop an implementation plan that uses teacher and faculty professional development to increase the participation of women and girls in STEM-related programs of study at the secondary and post-secondary level.

The Pipeline uses a five-step improvement process to guide efforts to improve gender equity in STEM education at the high school and community college level. The process includes analyzing Perkins Act performance data to identify gaps; identifying root causes to determine the causes of performance gaps; selecting appropriate strategies to address performance problems; testing and evaluating potential solutions; and implementing fully tested solutions. A publication prepared by NAPE-EF, *Nontraditional Career Preparation: Root Causes and Strategies*, serves as an important tool in this five-step process.

Many successful strategies have been put in place in high schools and community colleges across the 11 states that benefit women and girls including:

- Implementing ongoing gender equity and nondiscrimination training in STEM education for faculty and staff.
- Introducing hands-on activities to engage students and connect STEM programs to the real world.
- Adopting strong career guidance, counseling, and career exploration activities in STEM fields for all students, including women and girls.
- Using role models and mentors to connect students to STEM careers.
- Involving the business and community in STEM programming.
- Creating a positive school climate for STEM education through cohort-based activities.

In addition to providing ongoing technical assistance and training to the 11 state teams, the Pipeline offers tools to educators and trainers across the country. Examples include a web-based virtual learning community and webinars on gender equity strategies in STEM education.

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APPENDIX 2

EXPERTS CONSULTED

V. Celeste Carter, Program Director, Division of Undergraduate Education, National Science Foundation

Mel Cossette, Executive Director and Principal Investigator, National Resource Center for Materials Technology Education, Edmonds Community College

Elaine L. Craft, Director, South Carolina Advanced Technological Education Center of Excellence, Florence-Darlington Technical College

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