AC 2011-693: TURNING LIMITED RESOURCES INTO INCREASED RECRUITMENT & RETENTION OF FEMALE STUDENTS IN TECHNOLOGY PROGRAMS

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Donna Milgram, the Executive Director of the National Institute for Women in Trades, Technology and Science (IWITTS), has dedicated her career to helping women succeed in fields that have been traditionally dominated by men – from engineering and auto technology to law enforcement and computer networking.

Initially, Ms. Milgram's work focused on helping women "survive" the workplace, but she quickly saw that institutional change was critical. She shifted to helping employers and the education and job training systems develop more female-friendly recruitment and retention practices. In 1994, Ms. Milgram founded IWITTS, the only national organization whose sole mission is to provide educators and employers with the tools they need to encourage women to enter and succeed in careers where they are under-represented. IWITTS' solutions include trainings, publications, products and technical assistance.

Since then, Ms. Milgram's work has taken her to 43 of the 50 states. She has consulted and conducted hundreds of trainings on recruiting and retaining women in technology education and related occupations for national, state, regional and local educational institutions, organizations and employers.

Ms. Milgram has served as Principal Investigator (PI) for several National Science Foundation (NSF) projects and a National Institute of Justice grant. She is currently PI of the CalWomenTech Project, a $2 million NSF grant awarded in April 2006. Through this five-year grant, eight California community colleges have received training and technical assistance to help recruit and retain women into technology programs where they are under-represented. The Project was highlighted by NSF in 2009 for demonstrating significant achievement and program effectiveness.

Turning Limited Resources into Increased Recruitment & Retention of Female Students in Technology Programs

Abstract

The CalWomenTech Project, funded and highlighted by the National Science Foundation, has assisted eight California college technology programs in recruiting and retaining more women during an economic recession and state budget crisis that has forced California two-year colleges to cut $520 million in the 2009/2010 academic year alone. Even in this tough economic environment, the Project model and Project strategies—many requiring minimal costs and time commitments—have resulted in increases of female students in technology programs where they are underrepresented and in improved completion rates for both female and male students. The CalWomenTech Project's numbers on the recruitment and retention of technology students—both female and male—have been compiled by an external evaluator.

The Project has worked with the CalWomenTech colleges to distribute two surveys to the targeted female technology students that ask them what recruitment and retention strategies they have experienced, which ones they find helpful, and which strategies they would like to experience more (2009 survey n=60, 2010 repeat survey n=43). The results from these surveys have allowed the colleges to see what strategies take the fewest resources and yield the highest return for their students. Most of the strategies female students indicate have been most helpful to them are word of mouth recruitment strategies and classroom and curriculum retention strategies that can be implemented right away with little to no funding.

The Institute for Women in Trades, Technology and Science (IWITTS) attributes its positive CalWomenTech Project results to its project model, which is institutional and integrative involving all of the key stakeholders in a college. IWITTS believes that institutional models bring about lasting change because when the focus is on improving the STEM learning environment—rather than surviving it—both female and male students benefit.

Project Models for Increasing the Number of Women in STEM

A number of models exist for programs and projects working to increase the number of women in science, technology, engineering, and mathematics (STEM) programs in which they are underrepresented. Models typically fall into one of two categories—parallel support programs for women that exist separately from a STEM department and projects that attempt to enact institutional change by working through the STEM departments themselves—with some overlap occurring between the two. Parallel support programs often offer support to female STEM students throughout their time in a college or university STEM program by providing services such as mentoring, female-specific study groups, academic counseling, residential halls for female STEM students, additional research opportunities, summer bridge courses on basic skills, and/or events for the female STEM student community[1,2,3,4]. Some programs may opt to focus on one or two services—only offering living and learning communities in residential halls for example—while others may try to offer the full range of support services[2,4].

Both female STEM support programs with limited offerings and those with extensive services have achieved positive outcomes including higher grade point averages for female students benefiting from a program[2], increased numbers of STEM degrees awarded to women at some institutions with support programs[4], or simply a "positive influence" as self-reported by the female students[1]. A clear benefit of having an official support program is that most of the programs have dedicated staff with gender equity expertise, and as Fox, Sonnert, and Nikiforova discuss in their 2009 paper reviewing programs for undergraduate women in science and engineering, "directors in the most successful group of [women in engineering] programs had higher average time (seniority) in the position: an average of 7.2 years in the most successful and an average of 2.4 years in the least successful group[4]."

A downside to having service-heavy support programs is that the programs are vulnerable to fluctuations in funding and can be one of the first budget lines eliminated during an economic downturn. If a support program is canceled, all support for female students in STEM at an institution can disappear with the program—especially if that program has not worked with the STEM departments to institutionalize change. As Fox, Sonnert, and Nikiforova conclude in "Successful Programs for Undergraduate Women in Science and Engineering: Adapting versus Adopting the Institutional Environment," it is the support programs that are "institutional/structural-centered" or in other words the programs that observe and work to sustainably change certain issues they see within the institution that are the most successful at increasing the number of degrees awarded to women in science and engineering, and not the "individual/student-centered" support programs that focus more on helping individual female students "cope" within existing structures[4]. This research underlines the importance of working with STEM departments to effect institutional change for women in STEM either as a separate support program or as a project within a department.

The second category of model discussed here—projects (and programs) that attempt to enact institutional change by working through the STEM departments themselves—has as its primary focus change within the department, institutionalization, and sustainability. While this integrative model has existed for some time, it is less common than pure support programs. Two examples of institutions that have achieved positive outcomes by working within STEM departments—with STEM faculty and administrators—include Carnegie Mellon and New Mexico State University. At Carnegie Mellon, the percentage of women entering the School of Computer Science went from 7% to 42% in five years, after a two-year (extended to four year) combination project and program made a series of institutional changes. A few of the Carnegie Mellon interventions included adding real-world examples to computer science curriculum, offering pre-entry summer bridge courses, creating four alternative paths into the program, professional development for faculty, and creating support networks between female undergraduates, graduate students, and faculty[5]. New Mexico State University concentrated on one strategy—offering retention training to STEM faculty—which helped to improve both retention rates and grades of female students[6]. The downside to this integrative and institutional-change model is that these short-term projects and programs do not include long-term dedicated staff to carry out strategies; however, this heavier reliance on STEM faculty and administrators means that the projects are less vulnerable to fluctuations in funding and that they encourage the full "buy in" and support of those same faculty members and administrators.

In its own project model, the Institute for Women in Trades, Technology and Science (IWITTS) has chosen to focus on this integrative and institutional approach for increasing the number of women in STEM for several reasons: 1) out of a belief that focusing on strategies for instruction and department culture is the key to lasting change; 2) faculty and administrators who are not "experts" on gender equity are more likely to become so when there is not one "go to" person designated in this role; 3) because strategies to increase the number of women in STEM continue when there is no money to support an additional program and cannot be eliminated with budget cuts; and 4) because an institutional approach will continue beyond the life of a funded program or project.

IWITTS' project model has been used in three national demonstration projects, two funded by the National Science Foundation and one by the US Department of Labor, all with positive numerical outcomes as measured by external evaluators. The IWITTS project model utilizes a top-down leadership team approach. In the CalWomenTech Project for example, each college has a key leader and a co-leader along with a leadership team of ten key stakeholders. The key leader, in many cases, is the dean or department chair that oversees the technology programs or is the dean of workforce development. The co-leader is often a key instructor. Leadership team members include:

- Dean/chair of targeted program(s)/department(s)
- Faculty in program(s)/department(s)
- Recruitment/Outreach Director
- Public Information Officer
- Director of Counseling and/or staff
- Director of Tutoring/Learning Resource Center and/or staff
- Equity/Women's Center Coordinator (if available)
- Representative from feeder high school(s)

The leadership team and all program instructors receive WomenTech training on recruitment and retention and participate in development of a strategic plan, which is updated annually. The key leader, co-leader, and sometime other members of the leadership team meet with IWITTS on the phone once a month for an hour—for coaching and assistance on strategic plan implementation. Between calls, assistance is offered by IWITTS to the colleges via in-kind support—and ranges from development of marketing collateral such as posters to additional follow up sessions on retention training to instructors on-site. Annually all of the colleges come together for a one-day Project Partner Meeting to share their successes and strategies with one another. In the final phase of the Project, each of the colleges has included institutionalization strategies in their strategic plans.

Project Model Recruitment Results

The CalWomenTech Project has increased enrollment of female students. Six out of seven remaining CalWomenTech colleges have had increases in female student enrollment in introductory courses from baseline in the three or so years since they began working with IWITTS. Introductory courses are those which the colleges can recruit for directly and they provide a pipeline for the enrollment of females in advanced courses, for which they are a

prerequisite. As of spring 2010 San Jose City College (SJCC) withdrew from the Project. Since the key leader and many other Leadership Team members had left the college due to job changes and budget cuts, unfortunately, it was not feasible for SJCC to continue in the Project.

The progress of the CalWomenTech sites in increasing the enrollment of female students can best be seen by looking at trends over time. When enrollment numbers of female students are mapped out over all semesters starting from baseline, positive trends emerge that are harder to see when only looking at an aggregate of enrollment numbers, from Project inception to date. For example, City College of San Francisco's (CCSF) introductory computer networking courses have increased by 8.2 percentage points in aggregate—a significant increase. However, Figure 1 is a college enrollment progress chart developed by the Project's external evaluators on CCSF's introductory courses, which shows their enrollment started at an 18.8% baseline and climbed to 35% by the spring of 2010—an increase of over 16 percentage points.

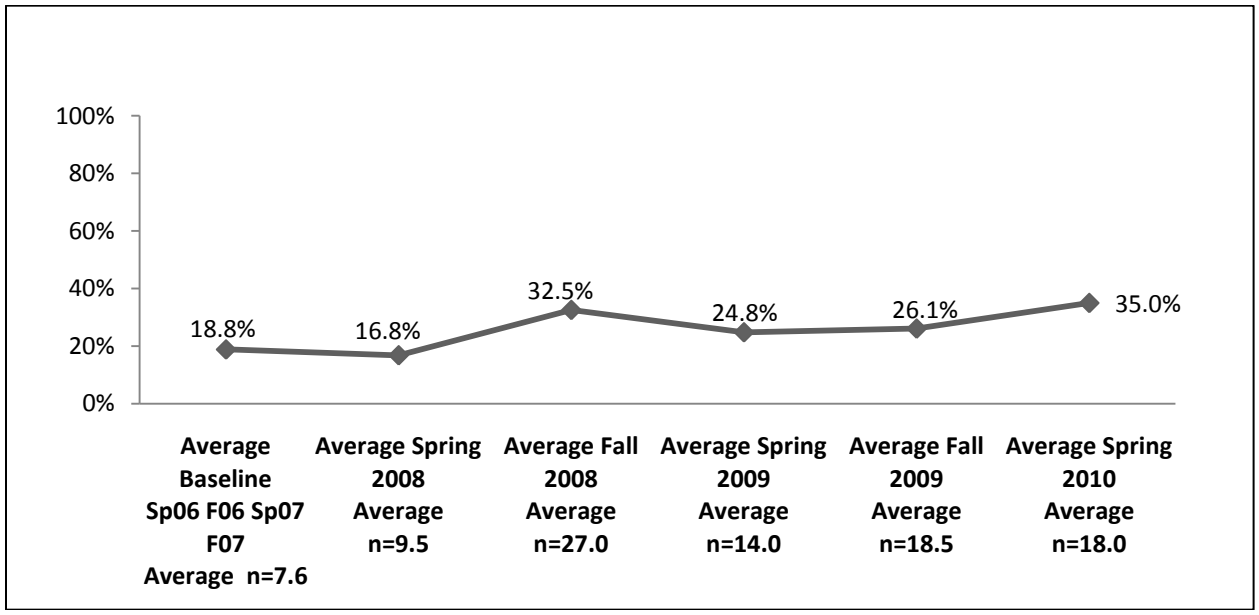

Figure 1: Recruitment Progress Chart: City College of San Francisco (CCSF) Female Enrollment Percentage in All Introductory CalWomenTech Project Targeted Courses

The aggregate numbers across the Colleges, along with the number of female students, will be calculated by the Project's external evaluators in the final report to NSF and will be broken out by both introductory and advanced courses. Some work has also been done by them to correlate strategies and implementation effort to successful numerical outcomes; this will be fully explored in the Final Report.

Recruitment Strategies

How did the CalWomenTech colleges achieve an increase of female student enrollment? In 2009 and 2010 an anonymous survey was administered to all female students across the targeted technology programs—in 2009 the external evaluators collected 60 survey responses and in 2010

they collected 43 responses. The number of responses was likely smaller in 2010 because a similar version of the 2009 survey was administered to the same pool of female students and thus was a repeat for some students. The external evaluators were unable to provide a response rate due to the limitations of an anonymous survey.

To establish which CalWomenTech recruitment strategies have had the greatest impact female students were asked in the survey, "Prior to enrolling in a technology course, please indicate the activities you attended or information you saw or received about technology courses or programs at you college."

The top recruitment activity as reported by 46% of female students from the 2010 survey is, "Heard about the technology program from an instructor." In the WomenTech recruitment and retention training provided to all of the CalWomenTech colleges early in the Project, one of the recommended strategies for increasing the recruitment of women was issuing a personal invitation to female students. This is a no cost strategy. The second most highly ranked strategy—with 40% of female students indicating exposure—are the "CalWomenTech Role Model Posters." These CalWomenTech posters feature quotes and photos of real female role models—either female graduates from the technology program (preferred), current female students, or female role models from local industry—working with authentic equipment. There is some cost involved in poster development and distribution; however, it is relatively low when an in-house or inexpensive online printing service is employed. The third ranked strategy—experienced by 29% of females—is another no-cost strategy, "Heard about the technology program from a counselor or advisor." Again, one of the recruitment strategies suggested during the WomenTech training on recruitment to the CalWomenTech leadership teams was making presentations and providing materials—such as program posters, flyers, and brochures with female role models—to educate counselors about the need to recruit more women to STEM programs. Following a close fourth and fifth—both experienced by 25% of female students—is, "Visiting the CalWomenTech section of the College's Website," and the "CalWomenTech Flyer." Both developing a small section of an existing program website especially for female students and printing female-specific, tear-off flyers with an instructor's contact information that students can tear off to take with them are strategies with some initial cost involved; however, it can be a reasonable one when the work is done in-house.

The CalWomenTech Project model includes faculty, administrative, counseling, and outreach executives and staff on the leadership team as well as the public information officer when possible. The result is that the recruitment of women in STEM is seen as a shared responsibility for everyone at the college and staff view the recruitment strategies as part of their normal job responsibilities. A heightened awareness of the importance of personal invitations to women in STEM by instructors, counseling, and outreach staff in the CalWomenTech Project has resulted in personal invitations to female students and potential applicants, along with the distribution of marketing and outreach collateral featuring female role models. According to the female students surveyed, it is these strategies that have resulted in increases in enrollment of female students in the technology programs.

Project Model Retention Results

A major highlight of the CalWomenTech Project continues to be the improved completion rates of both women and men across colleges, and as with enrollment the positive trends in retention taking place over the Project can be seen most clearly in the college progress charts created by the Project's external evaluators. IWITTS attributes this success in retention to classroom learning strategies employed by instructors that have positively impacted female and male students alike.

Four of the seven CalWomenTech colleges have improved the retention of women in both introductory and advanced courses through spring 2010. Two of the technology programs have increased the completion rates of female students by over 30 percentage points from baseline in introductory courses. Las Positas College has gone from 66.7% to 96.7% on average—an increase of 30 percentage points—and Evergreen Valley College from a baseline of 50% to 91.7%—an almost a 50% increase in the number of women completing targeted courses each semester on average. Male completion rates have also significantly increased at these two colleges—from 88.2% to 96.2% at Las Positas College and from 60.8% to 84.2% at Evergreen Valley College in all courses—and at three of the other colleges as well. Originally, IWITTS anticipated that the outcome of the CalWomenTech Project would be a comparable retention rate for women and men rather than significant increases in completion rates for both genders, so this unanticipated result has been an exciting development in the Project. When the CalWomenTech Project shows new instructors, conference/workshop participants, administrators in charge of institutionalization, and visitors to iwitts.org that Project strategies can increase completion rates of all students the acceptance of these strategies comes more quickly and easily.

These aggregated numbers do not convey the whole story for programs such as the CNIT program at CCSF when it comes to analyzing their progress. As of spring 2010, CCSF's completion rates for female students have increased from 64.1% at baseline to 75.5% on average—a significant increase of 11.4 percentage points. However, it is only by looking at their retention progress chart (see Figure 2) that it becomes possible to map out the time periods where CCSF started focusing on retention and when their efforts started paying off—or in other words to tell the story of their success in a way that allows the Project to pinpoint effective strategies. After a slow start on retention (when their efforts were concentrated on recruitment), CCSF made the decision to focus on improving completion rates—working to get the buy in and involvement of all the instructors from fall 2008 to fall 2009—and started to see a steep climb in their numbers. In spring 2009, CCSF's female completion rates reached 90.3% and in spring 2010 they topped out at 91.7%—an increase of 27.6 percentage points. Male completion rates have also increased at CCSF from 72.1% to 89.3% (see figure 3).

The unanticipated positive outcomes for male student retention is an area for further research. Since male students were not the focus of this Project, no demographic data exists for this group. The demographic data of the female students—who participated in a Project survey—is two-thirds minority, with the largest segment—25% of survey respondents—being Hispanic. IWITTS speculates that the male demographic is similar to that of the female students and that the CalWomenTech Project model likely benefits underrepresented men in technology programs as well as women.

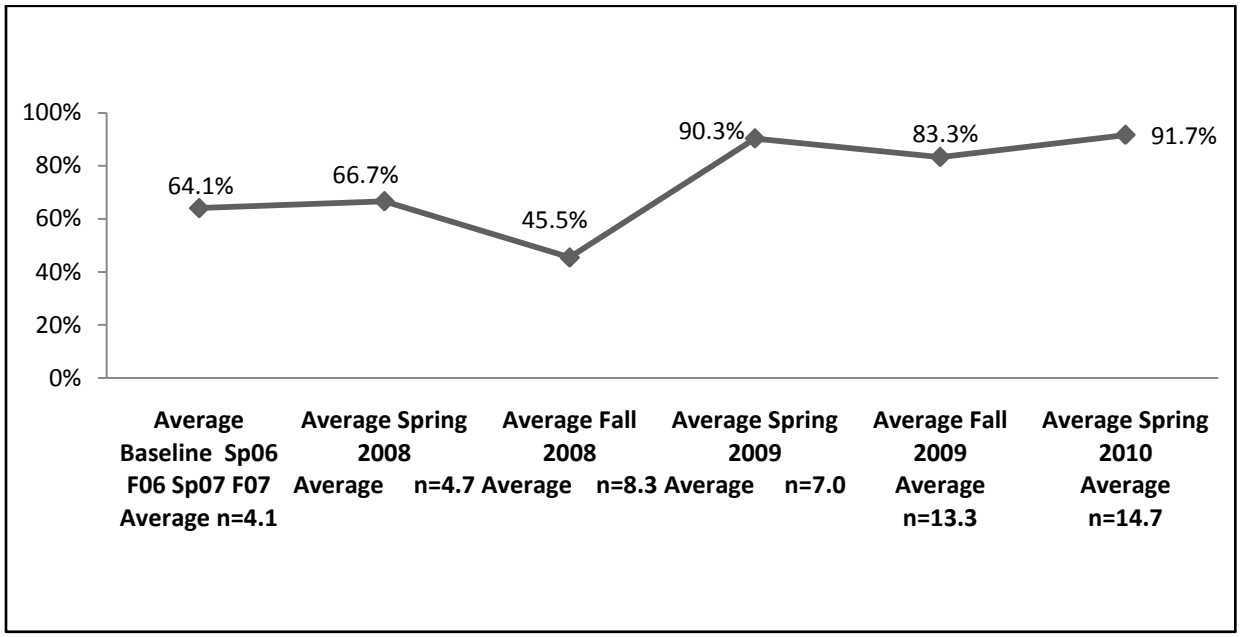

Figure 2. Retention Progress Chart: City College of San Francisco (CCSF) Female Completion Percentage in All CalWomenTech Project Targeted Courses

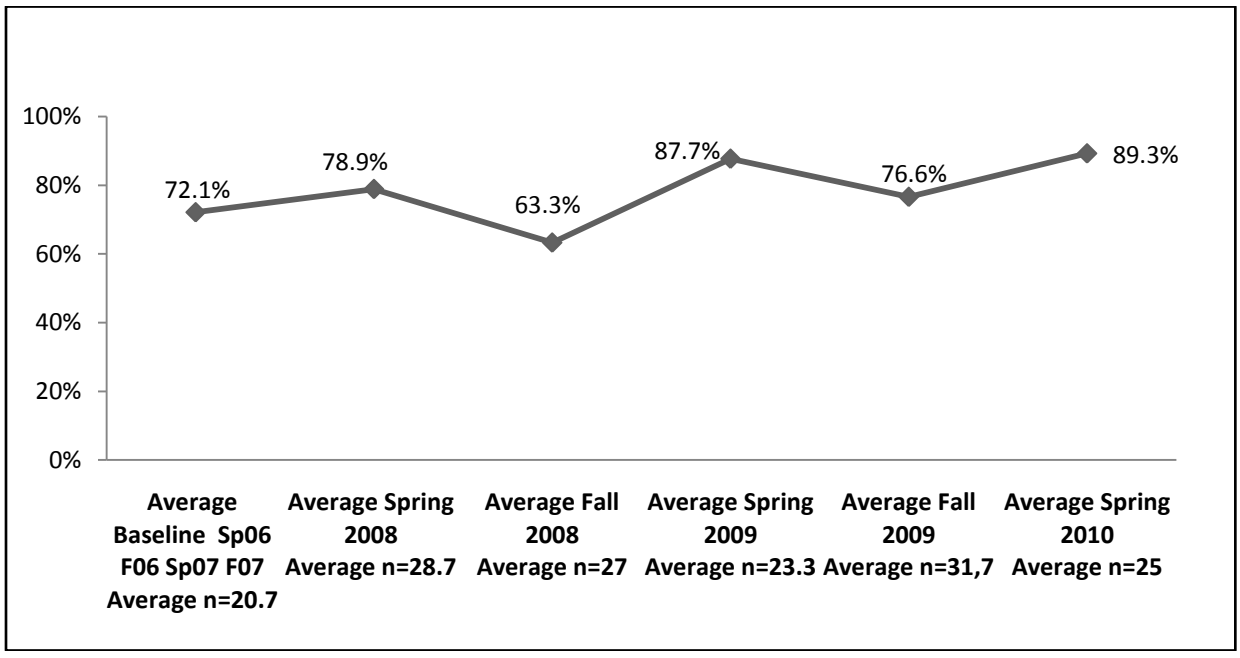

Figure 3. Retention Progress Chart: City College of San Francisco (CCSF) Male Completion Percentage in All CalWomenTech Project Targeted Courses

Retention Strategies

The improved retention of both women and men in the classroom across the CalWomenTech college sites has been a major highlight of the CalWomenTech Project, which IWITTS attributes

to classroom strategies employed by instructors that have been experienced by and positively impacted both female and male students. When offered a extensive menu of recruitment strategies—including both female-specific support services such as a "Women in Technology" club and more classroom-focused strategies such as further retention training for technology instructors—during the WomenTech training, the colleges chose to focus on improving faculty professional development and providing "bridge" skills to students rather than on other female-specific strategies.

IWITTS knows that the classroom strategies chosen were actually implemented by instructors and experienced by the female students because of the survey of female technology students in the targeted programs conducted in 2009 and again in 2010 (2009 survey n=60, 2010 repeat survey n=43).

The results of the "Survey of Female Technology Course Students" administered by the Project's external evaluators in spring 2009 and 2010 are invaluable in determining if the 20/21 major retention strategies that faculty received training on have actually been experienced by the female students, if they were helpful, and what strategies female students had not experienced that they wanted to going forward.

According to IWITTS' external evaluators, in 2009 fifty percent or more of the survey respondents reported exposure to 12 of the 20 classroom retention strategies listed in the survey, and in 2010 nine of the 21 listed strategies had 50% or more of respondents reporting exposure. Twenty of the 21 strategies were rated helpful or very helpful of those exposed. At least 50% or more of those female students who have not experienced each of the 20 strategies are interested in experiencing them in the future[7].

In 2010, the top three rated retention strategies by female students include:

- "The 'big' idea or theory was given before starting to learn specific concepts." 100% found it helpful and 86% had experienced it.
- "Learned basic skills needed for the course during the first few weeks of a course." 100% found it helpful and 84% had experienced it.
- "Instructor demonstrated or modeled before we did lab activities." 100% found it helpful and 84% had experienced it.

In 2009, "learned basic skills" was the number one strategy, "instructor demonstrated or modeled" was number two, and "was taught modules or small sections of instruction focused on one aspect of a course" was number three.

These top strategies represent two areas of focus in the WomenTech training provided to the CalWomenTech colleges. First, teaching to female learning style—many women prefer to know the context before diving into technical details and many want to see a lab concept demonstrated before actually carrying it out[8]. Second, frequently women are in need of assistance with technology building block skills they may have less previous experience with, which are often assumed in many technology curriculums. Increasingly, CalWomenTech faculty members report that male students often do not come with these problem solving skills either.

Subtracting the faculty professional development on retention, the top strategies rated by the students cost nothing. Some other retention strategies that the female students were also interested in experiencing do require some funding. For example, in 2010, 60% of the respondents wanted more open lab time, 44% wanted tutoring related to course content, 42% wanted tutoring on tool identification, and 41% wanted tutoring on spatial reasoning.

In some colleges—such as City College of San Francisco—additional open lab time has been provided by paying a small amount to female and racially-diverse students serving as lab aides. In another college, students have received additional open lab time by attending a class section that they were not enrolled at the invitation of the instructors, if there was sufficient space. Both female and male students have taken advantage of this policy. Videos on tool identification have also been provided to female students in the CalWomenTech programs wanting assistance in this area, and tutors were prepared to assist with spatial reasoning with an off-the-shelf, NSF-tested curriculum on this subject—both low cost strategies. Tutoring remains a significant expense, though in some cases other institutional budgets can be accessed.

Conclusion

The CalWomenTech Project employs an institutional and integrative Project model, with low and no cost strategies, which has so far enabled seven of its eight community college sites to continue with the Project despite severe budget cuts in the California education system. Almost all of the remaining seven colleges have seen increases in enrollment of female students and improved retention of both female and male students as measured by an external evaluator. It is to this project model—used by IWITTS in three national demonstration projects to increase the number of women in STEM programs where they are underrepresented—that IWITTS attributes the positive results of the CalWomenTech Project.

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