

Tracking Women and Minorities as They Attain Degrees in Computing and Related Fields

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Abstract

Two Maryland colleges (one a four-year liberal arts college for women, and one a public community college) have worked to increase the number of graduates, especially women and other under-represented groups, in their computer science, computer information systems, engineering, and mathematics programs over a four-year period. In August 2004, they were each awarded funding by the National Science Foundation to create a Computer Science, Engineering and Mathematics Scholarship Program, offering need-based scholarships for full-time students with a minimum grade point average, and U.S. citizenship or status as permanent resident alien or refugee alien. Faculty mentoring, a seminar luncheon series, and career information were features used to increase degree attainment. Results of these efforts are described.

Keywords: computing fields, graduates, mathematics, mentoring, minorities, NSF, retention, scholarships, seminars, STEM, transfer rate, women

1. WOMEN AND MINORITIES IN COMPUTING FIELDS

In its 2006 report, *In the Center of the Storm: Addressing the Challenges of Maryland's Tightening IT Labor Market*, the statewide Task Force on the Status of Women

and Information Technology (Taskforce, 2006) noted that new enrollments in computer science departments had dropped by 46% since 2001 (CRA Taulbee, 2006). There was a 79% decline in the number of incoming undergraduate women interested in majoring in computer science between 2000

and 2008 (NCWIT, 2009). One of the Taskforce recommendations for expanding education opportunities and supporting the recruitment and advancement of women in IT and related technologies in the workforce is to, "Provide access to electronic and/or traditional mentoring for every computer science and engineering college student through employment to increase retention" (Taskforce, 2006).

The potential of community colleges to increase the numbers of women and underrepresented groups in Science, Technology, Engineering and Mathematics (STEM) fields should not be underestimated. "For example, 64% of American Indian/Alaskan Native, 50% of African American, and 55% of Hispanic science and engineering bachelor's and master's degree recipients in 2004 and 2005 attended community colleges" (NACME, 2009). The fastest-growing major segment of higher education is community colleges (NSB, 2004). According to the Center for Policy Analysis at the American Council on Education, "The nation's community colleges witnessed tremendous growth in enrollment during the 1990s, outpacing all other major postsecondary institutions" (ACE, 2004). It has been projected that in 2010, 47.9% of the workforce will be female and 26% will be African American or Hispanic (BLS, 2001). Although 57% of U.S. undergraduate degree recipients in 2008 were women, in that year just 18% of computer and information sciences undergraduate degree recipients were women (NCWIT, 2009).

According to the National Science Foundation's Division of Science Resources Statistics, enrollment in U.S. graduate schools grew from 1,596,037 in 1990 to 2,212,015 in 2005, an increase of 38.6%. However, enrollment in science and engineering fields grew from 397,041 in 1990 to 478,275 in 2005, an increase of only 20.5% (NSF, 2008).

2. CCBC - THE INSTITUTION

The Community College of Baltimore County (CCBC) is a three-campus system serving the greater Baltimore metropolitan area. In Fiscal Year 2008, 33% of the credit students were enrolled in transfer programs, 62% were female, and 31% were African American. Fall 2008 credit enrollment at CCBC

overall was 20,673 students of which 7,172 (35%) were full-time. Of the 1,973 graduates who earned Associate degrees (1,654) or certificates (421) in FY 2008, 58% were female and 25% were African American. The institutional rate of Pell awards provides one indication of the amount of unmet financial need. At CCBC in the 2007-08 academic year there were 6,898 Pell awards, 24% of the credit students received a Pell grant. Of these Pell awardees, 54% were African American, and 73% were female.

In August 2004, CCBC was awarded National Science Foundation (NSF) funding for a four-year Computer Science, Engineering, and Mathematics (CSEM) Scholarships project.

As shown in **Figure 1**, full-time credit enrollment at CCBC increased to 7,172 in Fall 2008. From Fall 2003 to Fall 2008, the number of full-time students majoring in the combined CSEM programs decreased, from 8.4% of the full-time credit enrollment in Fall 2003, to 6.0% of the full-time credit enrollment in Fall 2008. The largest drops occurred in the numbers of full-time students majoring in the Computer Information Systems and Computer Science programs, while the relatively smaller numbers majoring in Network Technology and Multimedia Technology increased, and the number in Engineering Transfer remained steady.

Figure 2 shows the Fall 2006 enrollment for CSEM major programs at CCBC by major, gender and associate's degrees awarded. Half (462) of the students in those programs were full-time in Fall 2006, and there were 75 associate's degrees awarded in those programs in 2007.

3. CND - LIBERAL ARTS COLLEGE FOR WOMEN

The liberal arts college, The College of Notre Dame of Maryland (CND), has a weekday undergraduate program for women, the majority of whom are full-time students. There is also a Weekend College for men and women, most of whom are part-time students, whose career and/or family responsibilities make weekend study preferable. The Fall 2007 enrollment at CND was a total of 1,476 undergraduates, and 1,926 graduate students, and 559 students in the Women's

College. The college is a leader among Maryland's private colleges in educating students of color (29.2% of undergraduates and 21.5% of graduate students). Also, 91% of students in the Women's College receive financial aid and approximately 40% are the first in their families to attend college.

Although enrollment in the full-time women's college decreased from 621 in 2005 to 510 in 2008, it's encouraging that enrollment in CSEMS fields increased from 3.4% of the full-time students in 2005 to 4.1% in 2008, as shown in **Figure 3**.

4. CSEM SCHOLARSHIP PROJECT AT CCBC

Characteristics of NSF CSEMS Projects

NSF-funded CSEM Scholarships are intended to promote full-time enrollment and degree achievement; provide educational opportunities to academically talented, low-income students; and to encourage under-represented groups including women to enter these careers. Individual awards may not exceed \$3,125 or the student's unmet need per year as determined by completion of the Free Application for Federal Student Aid (FAFSA). Federal funding to support this NSF scholarship and student support services program is derived from H1-B visa fees collected by the U.S. government for each foreign worker in these fields. Because the goal of this scholarship program is to train U.S. students to provide high-tech skills needed for national competitiveness, scholarship recipients must be United States citizens, nationals, refugee aliens, or permanent resident aliens. Scholarships are awarded to full-time students in CSEM degree programs for eligible attendance expenses including tuition and fees, housing and food allowance, books, supplies, transportation, and dependent care. Each institution can determine its own additional criteria for award and renewal of CSEM scholarships.

Targeted Major Programs in the CCBC CSEM Scholarship Project

NSF funding for the four-year CSEM scholarship project, *Promoting Computer Science, Engineering, and Mathematics with Scholarships and Student Support Services*, (DUE-0422225), enabled CCBC to award approximately 29 scholarships per year (CCBC, 2008) together with related student support

services. Computing field associate degree programs targeted by this project are: the Multimedia Technology (MULT) program that includes the 2+2 Simulation and Digital Entertainment bachelor's degree program with a local four-year university; the Computer Science (CMSC) transfer program; and the Computer Information Systems (CINS) and Data Communications and Network Technology (DCOM) programs that prepare students for entry-level employment or transfer to a four-year institution. The newer E-Business (EBUS) career program is also targeted, as are the Mathematics (MATH) and Engineering (ENGR) transfer programs.

5. RECRUITMENT AND SELECTION OF CSEMS AWARDEES AT CCBC

Recruitment of Scholarship Applicants

The CCBC CSEM Scholarship program was advertised via the CCBC website, application form and brochure, and through an 8-minute CCBC Cable TV segment. CCBC CSEM Scholarship tri-fold brochures with eligibility criteria and contact information were designed and printed internally. Recruitment efforts included: sending email to all CCBC faculty and staff in the months before CSEM applications were due, or posting information on *The Daily Post*, a CCBC intranet; providing Financial Aid Offices on all three campuses with brochures and applications for the CSEM scholarships; providing CCBC Counseling Offices with brochures; and providing brochures for Baltimore County Public School (BCPS) seniors to BCPS high school counseling offices. Applications and tri-fold brochures were given to all mathematics faculty to distribute to interested students. This material was also distributed through faculty in other targeted programs. Fall 2008 was the last semester of CSEM scholarship awards at CCBC. Recruiting for CSEMS for Fall 2008 was limited to the 25 CSEMS awardees from Spring 2008.

Mathematics Placement Criteria

Seventy percent (70%) of entering CCBC students require non-credit developmental mathematics courses. To increase retention of awardees to degrees in CSEM programs and to motivate potential awardees to begin taking mathematics courses early in their college careers, CSEM awardees had to demonstrate readiness to take MATH 082 Introductory Algebra (the middle level of

developmental mathematics) or higher. This could be done by obtaining an appropriate score on the *Accuplacer* Mathematics placement test, or by completing the prerequisite developmental math course.

Selection of CSEMS Awardees

Before the fall and spring semester classes began, in mid-August and mid-January the Scholarship Committee (including faculty mentors from CSEM fields and a representative from the CCBC Financial Aid Office who had previously provided verification of each applicant's unmet financial need and citizenship status) met to select new awardees and to determine which awards should be renewed from the previous semester, which should be renewed probationally, and which should not be renewed, based on renewal criteria of 2.5 GPA and completion of 12 billable credits in a CSEM associate's degree program.

The CSEM award goes to the student's college account and is applied to tuition, books, and fees. After those expenses are paid, the remainder goes directly to the student and can be used to meet the student's many indirect educational expenses including transportation, childcare, and the basic living costs of food and shelter.

Awards Made by CSEMS Project at CCBC

From Fall 2004 through Spring 2008, an average of 27 students per semester were awarded CSEM scholarships, and in Fall 2008, 11 scholarships were awarded. (Tupper, 2008) provides the distribution of CSEM awards from Fall 2004 through Fall 2008 by degree program, semester, and gender. As shown there, 75 individual CCBC students (50 male and 25 female) received CSEM Scholarship awards during the four-year period from Fall 2004 to Fall 2008, in the participating associate's degree programs. Specifically, 16 awardees were in CINS or DCOM, 12 in CMSC, 1 in EBUS, 26 in ENGR, 12 in MULT, and 8 in MATH. Some students received the award for just 1 semester; one received it for 8 semesters; and one received it for all 9 of those semesters. The average length of award for all 75 awardees was three semesters. This was also the average for White, African American, and Asian subgroups of awardees. The average length of award for Hispanic awardees was two

semesters. Most awards were for \$3,125 per year.

By Fall 2008, NSF had revised its CSEM Scholarship program, renaming it as Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM). CCBC had recently been notified that its S-STEM project proposal focusing on STEM transfer program scholarships would be funded. The eligible major programs for the CSEMS project and the S-STEM project at CCBC differed as follows. Both projects could provide scholarships to students majoring in CMSC, ENGR, and MATH. But only the CSEMS project provided scholarships for students majoring in CINS, DCOM, EBUS, and MULT. The Scholarship Committee decided to award CSEM scholarships to students majoring in CINS, DCOM, EBUS and MULT, and to consider the students majoring in CMSC, ENGR, and MATH for the S-STEM funding. Seven former CCBC CSEM awardees were selected as S-STEM awardees in Fall 2008. Outcomes for these students are included in this paper as part of the 75 CSEM awardees.

6. CSEM SCHOLARSHIP PROJECT AT CND

Targeted Major Programs in the CND Liberal Arts College CSEM Scholarship Project

The four-year project, *The Cordia Karl Scholars Program: Preparing Women for Leadership in Computer Science, Engineering and Mathematics (DUE 0422449)*, provided NSF funding to support twenty-three academically talented women with demonstrated financial need, enabling them to complete a bachelor's degree in Mathematics, Computer Science, Computer Information Systems, or Engineering. The Cordia Karl program was named in honor of the founding chair of the Mathematics Department to underscore the College's historic commitment to the development of women for leadership in mathematics and the sciences.

CSEMS Project Objectives

Objectives of this four-year project at CND were:

- Expand educational opportunities for students majoring in Computer Science, Computer Information Systems, Engineering, or Mathematics

- Increase retention of students to degree achievement in CSEM majors
- Enhance the college's support programs for students in CSEM majors
- Strengthen partnerships between the college and the local high-technology industry.

7. SELECTION OF CSEMS AWARDEES AT CND

Recruitment of Scholarship Applicants at Liberal Arts College

The CSEM Scholarship program was promoted through the efforts of the admissions counselors, communications with the local community colleges, and the college web site. Prospective scholarship recipients were also selected from the current student population each year. Twelve scholarships were awarded FY06, twelve in FY07, eleven in FY08 and eleven in FY09, as shown in **Figure 4**. In annual surveys, fifty-two percent (52%) of the scholarship students reported learning of the program from printed materials (or Web page announcements), forty-seven percent (47%) reported hearing of the program through word-of-mouth.

Selection of CSEMS Awardees

Each year the PI and the college financial aid director met to determine which current students were eligible for the scholarship, considering GPA, full-time status, and participation in activities. CSEM faculty met to select new awardees based on high school or previous college GPA, courses taken, entrance essay and school activities.

The CSEM award goes to the student's college account and is applied to tuition, books, and fees.

8. FEATURES OF THE CSEMS PROJECT AT LIBERAL ARTS COLLEGE

Site Visits

Students participated in site visits to local government and industry facilities, including NASA Goddard Space Flight Center, attending a session in "Science on a Sphere" illustrating Goddard's contribution to understanding the Earth and beyond. A tour featured the design, fabrication, and testing of satellites and spaceflight instruments. The

focus was on the upcoming last servicing mission of the Hubble Space Telescope and the upcoming Lunar Reconnaissance Mission.

During the second year of the program, students visited Johns Hopkins Applied Physics Lab and met mathematicians, engineers and computer scientists who develop one-of-a-kind instruments for such specialized use as space travel. Students toured high-tech facilities and watched as computer chips were engineered in a 'clean' room.

In the third year students visited the Department of Defense Edgewood Chemical and Biological Center (ECBC). ECBC is a world leader in applying cutting edge science, engineering, and technology to chemical and biological defense products, systems, and services. Included in the tour was an overview of the history and function of the center, Advance Design Manufacturing, and the Advanced Chemistry Lab.

Student Research

Students conducted research and presented their research papers at meetings with advisory board members and on the college Student Research Day. One research project was a study that focused on student math understanding and remediation of math difficulty for school-age students and adults. Three senior scholarship students participated in the data collection, evaluation of errors, and preparation of results.

A second area of research was a Technology Survey of faculty and students at the college. The survey questions were designed and prepared by two scholarship students. Each survey had forty categories, from types of technology used to satisfaction with technology provided on campus. The survey was approved by the college Institutional Review Board and administered online. Participation included 106 students and 55 faculty.

Alumnae Panels

Students met with panels of alumnae who offered advice on working in male-dominated fields, giving valuable job-hunting and interviewing tips, as well as advice for surviving the first year of professional employment. A second panel advised students on the advantages of pursuing graduate work. These opportunities for forging connections between students and alumnae led

to internships, job opportunities and long-term mentoring.

Academic and Career Advice

The college Academic and Career Enrichment Center advised students on the graduate application and job search processes. Students met annually with an Advisory Board of local professionals in mathematics, computer science and engineering from the Johns Hopkins Applied Physics Lab, Lucent Technologies, Social Security Administration, and U.S. Army Corps of Engineers who provided detailed advice on academic choices and career goals.

9. AWARDEE SUPPORT SERVICES AT CCBC

Career Days for Awardees

One or two Orientation and Career Days for CSEMS awardees were held each August in the week before fall classes began. Career Day activities consisted of: an overview of the eligible CSEM degree programs; discussion of mentoring; completion of Consent Form, Attitude Questionnaire, and Mentoring Agreement; lunch with awardees' faculty mentors with time to discuss upcoming and long-range course registration plans. In addition, there was a guest speaker from a CSEM field, or a panel of professionals from various CSEM fields, or a panel of former CSEM awardees who had already transferred to four-year institutions. A similar Career Day was held each January in the week before spring classes began. Luncheon Seminars with guest speakers were held each October and April for awardees. Speakers were professionals from CSEM fields, or an CCBC employment services coordinator or internship coordinator to discuss resume writing, internships and job interview guidelines.

Mentoring by Faculty in CSEM Programs

High-quality connections between students and faculty can increase student retention in college. Astin identified the 3 most powerful forms of involvement contributing to student success as: "academic involvement, involvement with faculty, and involvement with student peer groups" (Astin, 1996). Cohoon found that mentoring and providing encouragement to persist were effective interventions for retaining women in compu-

ting majors at the undergraduate level (Cohoon, 2003). (NCWIT, 2008) provides mentoring resources online including a Mentor Guide, a Protegee Guide, and an Activities Guide.

Mentoring is an important aspect of the CCBC CSEMS project. Each CSEM scholarship awardee is assigned a CSEM faculty mentor based on his/her major and campus location. Since traditional CCBC students are not assigned specific academic advisors to guide them through college, the CSEM mentorship program is a major benefit for awardees. Each awardee must sign a Mentoring Agreement and mentoring logs are due monthly or bi-monthly from all mentors and mentees. The responsibilities of each student (mentee) and faculty member (mentor) are clearly communicated when the student first receives the award, and reinforced during the Summer Career Experience, and the Career Luncheon Seminar Series for awardees and faculty mentors. Over the nine-semester period from Fall 2004 through Fall 2008, a total of 17 CSEM faculty served as mentors for awardees. Each semester, there were about ten faculty mentors, each with one to five mentees. Mentees and mentors are expected to meet (in person, by email, or by phone) at least once a month, with twice-a-month meetings required early in the fall semester to establish a good mentoring relationship for the academic year.

Efforts to Increase the Transfer Rate

Another feature addresses the fact that some talented CCBC students do not even consider CSEM-eligible transfer programs because they cannot afford to continue their education beyond community college. The CCBC CSEM program encourages awardees to continue their studies at four-year institutions. The project proposal designated up to 20% of its scholarship funds to "follow" awardees who transfer to assist their completion of bachelor's degrees in these fields. In practice, 34% (76/224) of semester awards were made to CCBC CSEM awardees who transferred to four-year colleges.

Beginning with the first transfers of awardees in Fall 2005, 5 to 15 transfer CSEM awards were made each semester from Fall 2005 through Fall 2008. That is, scholarship renewal awards were made to former CCBC students who had transferred after earning

at least 30 credits at CCBC. CCBC faculty continued to mentor transferring awardees using email, phone and personal contact. To be eligible for the transfer scholarship awards, renewal scholarship students must provide documentation of their acceptance and full-time status at the four-year institution in a CSEM major; unmet financial need; and successful completion of prior coursework in a CSEM degree program. Offering students the option of transferring their CSEM scholarship along with their credits to a four-year institution enables students to reach greater success in a CSEM field.

10. DEFINING SUCCESS FOR CSEMS AWARDEES AT CCBC

Just as four-year colleges maintain data on the percentage of their students who graduate with bachelor's degrees 4, 5, or 6 years after entry, community colleges maintain data on the percentage of their students who transfer or graduate with an associate's degree 2, 3, or 4 years after entry. At CCBC, the four-year transfer and graduation rate (which counts those who transferred to a four-year institution and/or graduated with an associate's degree) of all 2,554 new full-time CCBC freshmen matriculating in all programs in 2004 was 32% (24% transferred and an additional 8% graduated but did not transfer), 13% were still enrolled at a Maryland community college, and 55% had dropped out without transfer or graduation. (MHEC, 2009)

For the state of Maryland, the four-year transfer and graduation rate of all 14,527 new full-time freshmen matriculating at Maryland public community colleges in 2004 was 35% (26% transferred and an additional 9% graduated but did not transfer), 12% were still enrolled, and 53% had dropped out from college. Among the 16 public community colleges in Maryland, the four-year transfer and graduation rate ranged from a low of 15% to a high of 45%. Transfer and graduation rates for African American and Hispanic students in Maryland community colleges remain below the rates for White and Asian students. In the 2004 state cohort, the four-year transfer and graduation rate for African American students was 22%, and the rate for Hispanic students was 29% (MHEC, 2009).

Transferring CSEMS Awardees

A total of 49 awardees, including 14 women, had transferred to four-year institutions by the start of the Fall 2009 semester. Many (22/49 or 45%) of the transferring awardees have transferred to the University of Maryland Baltimore County (UMBC), with 9 others transferring to the University of Baltimore (UB), 5 others to University of Maryland College Park (UMCP), 3 to Towson University (TU), and 10 transferring to 7 other public and private institutions.

Transfer and Graduation Rate for CSEMS Awardees

Outcomes for all 75 CSEM awardees over the period from Fall 2004 through Fall 2008 are shown in **Figure 5**. Sixty-five percent had transferred to a four-year institution by the start of Fall 2009, an additional 12% had graduated with an associate's degree (but did not transfer), 17% were still enrolled (as of Spring 08 or later), and 5% had dropped out.

This 77% transfer and graduation rate for CCBC CSEM awardees after 4 years compares well with the CCBC four-year transfer and graduation rate of 32% (24% transferred and an additional 8% graduated). (MHEC, 2009) Twenty-four of those 49 CSEM awardees who transferred had also earned an associate's degree at CCBC.

Figure 5b presents these outcomes by Racial/Ethnic group. The transfer and graduation rate for the 23 African American CSEM awardees was 78% (61% had transferred, and an additional 17% graduated with associate's degrees). The transfer and graduation rate for the 36 White CSEM awardees was 70% (56% had transferred, and an additional 14% graduated with associate's degrees). The transfer and graduation rate for the 13 Asian awardees was 92%. A Fisher's exact test was performed to compare the transfer/graduation rates for White and African American awardees. This test showed no difference in the rates among the two Racial groups.

Bachelor's Degrees among Awardees

By the end of Spring 2009, 16 (3F/13M) of the total 75 CSEM awardees had earned bachelor's degrees as follows. One had earned both bachelor's and master's degrees in Mathematics at UMBC. Another had earned dual bachelor's degrees in Mathematics and Phys-

ics (UMBC) and is now pursuing graduate studies at the University of Iowa. Two had earned bachelor's degrees in CMSC (UMBC). Two had earned bachelor's degrees in Computer Information Systems (Stevenson University). Ten others earned bachelor's degrees in Chemical Engineering (UMBC), Civil/Environmental Engineering (UMCP), Electrical Engineering (UMCP), Mechanical Engineering (UMBC), Information Systems (UMBC), Simulation and Digital Entertainment (UB), Information Technology - Digital Forensics (Johns Hopkins University), Biology (TU), Financial Economics (UMBC), and International Business (TU).

An examination of transcripts in July 2009 showed that in addition to the 16 (3F/13M) CSEM awardees who have already earned bachelor's degrees, there were 6 (2F/4M) others at UMBC in Spring 2009 who have earned over 100 credits toward their bachelor's degrees in Mechanical ENGR (2), Information Systems (2), CMSC (1), and Business Technology Administration (1). Only 2 of these 6 had earned an associate's degree at CCBC before transferring. There are also 8 other CSEM awardees who have not yet transferred and were at CCBC in Spring 2009. Five (5) of those 8 at CCBC in Spring 2009 have earned over 40 credits toward their associate's degrees.

Follow up data concerning the awardees' transfer and degree status has been continuously collected on all 75 CSEM awardees (50 male and 25 female) from Fall 2004 to Fall 2008. **Figure 6** contains this data. As of July 2009, 65% have transferred to a four-year institution, 44% earned associate's degrees (whether or not they transferred), and 21% earned bachelor's degrees. Nineteen (38%) of the male awardees and 14 (56%) of the female awardees have earned an associate's degree.

The male and female rates for earning bachelor's or associate's degrees were also compared. Twenty-four males (48%) and 17 (68%) females have earned either bachelor's or associate's degrees. A Fisher's exact test was used to see if the rate was higher for female awardees. A marginal increase in the rate was detected (p -value = 0.081). This could suggest that female awardees were more likely to receive their bachelor's/associate's degrees than male awar-

dees. The comparison of bachelor's/associate's degree was chosen over examining each degree separately because of such small values in the table. This slight increase for female awardees could be due to fact of such a large proportion of them receiving their associate's degree.

As shown in **Figure 6b**, the transfer rate among the 23 African American CSEM awardees was 61%, and the transfer rate among the 36 White CSEM awardees was 56%. The rate of attainment of bachelor's or associate's degrees was 57% among African American awardees, 56% among White awardees, and 62% among Asian awardees. A chi-square test of independence was used to see whether or not receiving a bachelor's/associate's degree was dependent on the awardee's race/ethnicity. A p -value of 0.932 indicates that receiving bachelor's/associate's degree is independent of the awardee's race/ethnicity.

11. OUTCOMES AT CCBC

Women and Minorities among CSEM Awardees at CCBC

For many years females have consistently represented the largest portion of CCBC graduates and credit students. However, the percent of women in CSEM programs at CCBC has been decreasing over the last 5 years in the CINS, CMSC, DCOM and MULT programs, as shown in **Figure 7**. The percent of female enrollment in ENGR has remained at approximately 15%.

The distribution of credit students at CCBC in Fall 2006 by racial/ethnic group as self-described at course registration was as follows: White 57%, African American 31%, Asian 5%, Hispanic 2%, and Unknown/Other 5%. Minority groups that have been underrepresented in CSEM fields nationally have been represented among the 75 CSEM awardees in proportions equal to or greater than their population percentage at CCBC. In particular, 48% of awardees were White, 31% were African American, 17% were Asian, and 4% were Hispanic. Women remain underrepresented in the CSEM Scholarship awards made at CCBC under this project. In the period from Fall 2004 through Fall 2008, 29% (64/224) of the semester CSEM awards at CCBC were made to wom-

en, and 33% (25/75) of awardees were women.

Awardee Attitude Survey at CCBC

Claudia Morrell, who was then Director of the Center for Women & Information Technology at UMBC, provided the Principal Investigator with a 24-question Likert-scale Attitude Survey Questionnaire (UMBC, 2009) (Mento, 2008). The survey was completed by each CCBC CSEM awardee at the start of each semester. Responses made by awardees to statements regarding the effect of CSEM role models were examined. Among results provided in (Tupper, 2008) was that awardees from groups underrepresented in CSEM fields (including females, African Americans, and Hispanics) showed a stronger opinion about the positive effect of CSEM role models upon them.

12. GRADUATION RATES AT CND

Bachelor's Degrees Among Awardees

By Spring 2009, 14 out of 23 students were awarded a bachelor's degree, 1 in engineering, 2 in computer science, 1 in computer information systems, and 10 in mathematics. This is a graduation rate of 60% of all women participants, and 60% of African-American participants. This is in comparison to the graduation rate in 2004 after 4 years in Maryland independent colleges which was 53.8% overall, 55.5% for women, and 30.8% for African-American students (MHEC, 2009).

Because freshmen enrolled in the scholarship program in its third and fourth years, six students have not graduated, but are continuing in the CSEMS majors at the college.

13. OUTCOMES AT CND

Women and Minorities among CSEM Awardees

From 2005-2009, twenty-three students were awarded CSEM scholarships. Twelve were majors in mathematics, 4 in computer science, 3 in computer information systems, and 4 in engineering, as shown in **Figure 4**.

While 29% of the women's college are women of color, 34% of the CSEMS students were women of color, and 30% of the

CSEMS graduating students were women of color (**Figure 8**).

Attitude Survey at CND

Students' activities and attitudes were measured at several points in the project, and compared to a group of non-scholarship science students. The attitudes were measured on a seven point Likert scale where 1=Strongly Disagree and 7=Strongly Agree. Awardees' concerns for the role of women in technology were initially higher than that of the comparison group, but moderated over time in the program (**Figure 9**). This is probably the result of the variety of opportunities for participants to interact with women in their fields, such as panels and field trips. It is hoped that these activities not only made the participants aware of women in the fields, but made the participants more comfortable in those roles.

The participant group ranged higher in their anticipation of a science and technology career. Interest in graduate school seemed balanced across all measures except for the seniors measured; there was a greater anticipation of graduate school for the participant group.

When participants' attitudes and expectations were evaluated longitudinally across their participation, several interesting results emerged. There was a negative correlation between early and mid-scores on the question of women in technology. This rather strong and significant correlation suggests that women who initially thought women were under-represented changed their opinions, and those who felt the opposite also changed theirs. There was also a significant change in the enjoyment of on-topic speeches and conferences. There was a decline in non-assigned reading on topic, but this result may be mitigated by the increasing amount of assigned reading as students progress through their college experience.

14. CONCLUSION

Unless colleges support women and minorities through scholarships, corporate mentoring, alumni partnerships, and faculty encouragement, the country faces a dire shortage of much needed highly educated professionals in computer science, mathematics, and engineering.

From Fall 2004 through Fall 2008, CCBC used NSF CSEM Scholarship funding to attract and retain full-time students, particularly women and under-represented minorities, in CSEM major programs. Need-based scholarship awards were provided along with support services, including mentoring, and career and transfer information, to encourage graduation and/or transfer. The transfer and graduation rate for all 75 CSEM awardees has reached 77%. Specifically, 65% transferred to a four-year institution, 44% earned associate's degrees (whether or not they transferred), and 21% earned bachelor's degrees. The transfer and graduation rate for the 23 African American CSEM awardees is 78%, and that rate for the 36 White awardees is 70%. Minority groups (African Americans and Hispanics) nationally underrepresented in CSEM fields were represented among CSEM awardees in proportions equal to or exceeding their population percentages at CCBC. Although females formed 63% of the total CCBC credit enrollment in Fall 2006, they comprised only 25% of the total enrollment in CSEM programs. Thirty-three percent (33%) of CSEM awardees were female.

One of the lessons learned through CCBC's CSEM Scholarship program is the importance of early and continuous registration of STEM program students in mathematics courses, until completion of all the mathematics required for their degree programs. This, together with placement into Intermediate Algebra, or higher, is one of the eligibility and renewal requirements for awardees in CCBC's newly funded S-STEM scholarship program.

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Appendix

CCBC Program	Number of Full-Time Program Majors					
	Fall 2003	Fall 2004	Fall 2005	Fall 2006	Fall 2007	Fall 2008
Computer Information Systems CINS	263	174	102	89	82	68
Computer Science CMSC	145	106	108	91	97	106
Network Technology DCOM	39	39	51	56	54	57
E-Business EBUS*	-	6	20	25	30	23
Engineering Transfer ENGR	103	112	113	105	115	111
Multimedia Technology MULT	40	71	64	70	55	62
Total number in CSEM programs	590	508	458	436	433	427
CSEM % of all credit programs	8.4%	7.2%	6.5%	6.4%	6.5%	6.0%
All CCBC Credit Pro- grams	7,026	7,093	7,049	6,846	6,660	7,172
*NOTE: The E-Business program was new in Fall 2004.						

Figure 1. Number of Full-Time Majors in CSEM Programs 2003-2008 at CCBC

CCBC CSEM Major Program Enrollment in Fall 2006 with Numbers by Major, Gender, and Associate's Degrees							
Program	Full-Time Majors	Part-Time Majors	Total Majors	Male	Female (%)	Seeking Associate's Degree	Associate's Degrees Awarded 2007
CINS	89	138	227	146	81 (36%)	189	24
CMSC	91	87	178	144	34 (19%)	178	6
DCOM	56	85	141	116	25 (17%)	103	25
EBUS*	25	13	38	17	21 (55%)	32	0
ENGR	105	91	196	169	27 (14%)	191	6
MATH**	26	14	40	15	25 (62%)	40	4 (est.)
MULT	70	35	105	83	22 (21%)	94	10
Totals	462	463	925	690	235 (25%)	827	75

Notes: * The E-Business program was new in Fall 2004.

** Mathematics figures are estimated using Fall 2005 data. At that time Mathematics was one of 30 subareas under the Arts and Sciences Transfer Program. Nearly half the students in that program designated subcodes such as Mathematics, but degrees awarded did not specify the subarea. Effective in 2008, a new A.S. in Sciences degree program was available for just the science and mathematics transfer programs.

Figure 2. CCBC CSEM Major Programs in Fall 2006 with Numbers by Major, Gender, and Associate's Degrees

CND Program	Number of Full-Time Program Majors			
	Fall 2005	Fall 2006	Fall 2007	Fall 2008
Total number in CSEM programs	21	26	26	21
CSEM % of all credit programs	3.4%	4%	4.6%	4.1%
All CND Credit Programs	621	591	559	510

Figure 3. Number of Full-Time Majors in CSEM Programs 2005-2008 at CND

CND Program	Fall 2005	Fall 2006	Fall 2007	Fall 2008
Computer Information Systems	0	2	3	2
Computer Science	3	3	2	1
Engineering	1	1	2	2
Mathematics	8	6	7	8
Total	12	12	11	11

Figure 4. Number of Majors in Cordia Karl Scholarship Program 2005-2008 at CND

Racial/ Ethnic Group	Transferred to Four-Year Institution *		Graduated with Associate's Degree		Still Enrolled at CCBC **		Dropped Out	
	F	M	F	M	F	M	F	M
White	6 (4)	14 (9)	3	2	2	5	0	4
African American	3 (3)	11 (4)	2	2	4	1	0	0
Asian	3 (2)	9 (2)	0	0	0	1	0	0
Hispanic	2 (0)	1 (0)	0	0	0	0	0	0
TOTAL:	14 (9)	35 (15)	5	4	6	7	0	4
% of Females (n/25)	56%		20%		24%		0%	
% of Males (n/50)		70%		8%		14%		8%
% Combined (n/75)	65%		12%		17%		5%	
Notes: * Numbers in parentheses show how many of those who transferred also earned associate's degrees. ** As of Spring 2008 or later.								

Figure 5. Outcomes for All 75 CCBC CSEM Scholarship Awardees from Fall 2004 – Fall 2008 as of Spring 2009 by Racial/Ethnic Group and Gender

Outcome Category	Number (%) White	Number (%) African American	Number (%) Asian	Number (%) Hispanic	Number (%) Combined
Transferred	20 (56%)	14 (61%)	12 (92%)	3 (100%)	49 (65%)
Graduated / Not Transferred	5 (14%)	4 (17%)	0 (0%)	0 (0%)	9 (12%)
Still Enrolled (as of Spring 08 or later)	7 (19%)	5 (22%)	1 (8%)	0 (0%)	13 (17%)
Dropped Out	4 (11%)	0 (0%)	0 (0%)	0 (0%)	4 (5%)
Total:	36	23	13	3	75

Figure 5b. Outcomes for All 75 CCBC CSEM Awardees Fall 2004 - Fall 2008 by Racial/Ethnic Group(as of July 09)

Group	Transferred	Associate's Degrees	Bachelor's Degrees	Bachelor's or Associate's Degrees
Female Awardees (N=25)	14 (56%)	14 (56%)	3 (12%)	17 (68%)
Male Awardees (N=50)	35 (70%)	19 (38%)	13 (26%)	24 (48%)
Total Awardees (N = 75)	49 (65%)	33 (44%)	16 (21%)	41 (55%)

Figure 6. Transfer and Degree Completion by Gender among 75 CCBC CSEM Awardees from Fall 2004 - Fall 2008 (as of July 2009)

Racial/Ethnic Group	Number of CSEM Awardees	Transferred	Associate Degrees	Bachelor's Degrees	Bachelor's or Associate Degrees
White	36	20 (56%)	18 (50%)	8 (22%)	20 (56%)
African American	23	14 (61%)	11 (48%)	4 (17%)	13 (57%)
Asian	13	12 (92%)	4 (31%)	4 (31%)	8 (62%)
Hispanic	3	3 (100%)	0 (0%)	0 (0%)	0 (0%)
TOTAL:	75	49 (65%)	33 (44%)	16 (21%)	41 (55%)

Figure 6b. Transfer and Degree Completion by Racial/Ethnic Group among 75 CCBC CSEM Awardees from Fall 2004 - Fall 2008 (as of July 2009)

CCBC CSEM Program	% Female Enrollment					
	Fall 2003	Fall 2004	Fall 2005	Fall 2006	Fall 2007	Fall 2008
CINS	40%	42%	37%	36%	38%	32%
CMSC	27%	21%	23%	19%	23%	17%
DCOM	25%	20%	18%	17%	18%	13%
EBUS*	-	47%	58%	55%	45%	50%
ENGR	15%	15%	15%	14%	16%	13%
MULT	41%	29%	21%	21%	22%	19%
All CCBC Credit Programs	63%	63%	63%	63%	63%	62%

NOTE: The E-Business program was new in Fall 2004.

Figure 7. Percent of Females among CSEM Program Majors at CCBC from FALL 2003 through FALL 2008

Racial/Ethnic Group	Number in CND CSEM Program	Received Bachelor's Degrees	Continuing Undergraduate Major	Continuing Graduate School
White	15	10	5	2
African American	5	2	2	0
Asian	3	2	1	1
Total:	23	14	8	3

Figure 8. Outcomes for 23 CND CSEM Scholarship Awardees from Fall 2004 – Fall 2008 by Racial/Ethnic Group

Topic	CND Participant Group			Non-Participant Comparison Group	
	Entry	Mid-experience	Senior	Mid-experience	Senior
GPA		3.53	3.58	3.16	3.09
Feel women are under-represented in science and technology	5.25	4.83	5.0	4.82	5.0
Enjoy attending speeches and demonstrations related to science & technology	5.75	4.67	5.5	3.91	5.5
Regularly attend activities related to science & technology	3.81	3.58	4.0	3.18	4.0
Regularly read on topics related to science & technology	4.38	4.17	3.5	3.36	3.5
Anticipate attending graduate school in science & technology	5.31	5.58	5.0	5.64	3.0

Figure 9. Mean Scores for Attitudes and Activities of 23 CND CSEM Awardees from Fall 2004 – Fall 2008 (Scale 1 to 7)