

In this issue:

- 4. Information and Communication Technology in the Classroom: BYOD and the University's Role**
Gary Alan Davis, Robert Morris University
Frederick G. Kohun, Robert Morris University

- 12. Cyber Security Curriculum Development: Protecting Students and Institutions While Providing Hands-On Experience**
Jim Marquardson, Northern Michigan University
David L. Gomillion, Texas A&M University

- 22. Sprint, then Fly: Teaching Agile Methodologies with Paper Airplanes**
Mark Frydenberg, Bentley University
David J. Yates, Bentley University
Julie S. Kukesh, Mendix Corporation

- 37. Data Analytics Workshop Series for Non-Computing Major First-Generation-College-Bound Students**
Sam Chung, Southern Illinois University

- 45. Long-term Follow-up of STEM Scholarship Students to Degree Attainment**
Sylvia Sorkin, The Community College of Baltimore County

- 56. Do the Knowledge and Skills Required By Employers of Recent Graduates of Undergraduate Information Systems Programs Match the Current ACM/AIS Information Systems Curriculum Guidelines?**
Timothy Burns, Ramapo College of New Jersey
Yuan Gao, Ramapo College of New Jersey
Cherie Sherman, Ramapo College of New Jersey
Stephen Klein, Ramapo College of New Jersey

- 66. The Impact of Teaching Approaches and Ordering on IT Project Management: Active Learning vs. Lecturing**
Christopher Sibona, University of North Carolina Wilmington
Saba Pourreza, University of North Carolina Wilmington

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Long-term Follow-up of STEM Scholarship Students to Degree Attainment

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Abstract

This paper describes the results of long-term follow-up of need-based scholarship awardees at a community college as they made progress toward their goal of associate's degrees and/or bachelor's degrees in Science, Technology, Engineering, and Mathematics (STEM) fields. From 2004 through 2012, through National Science Foundation funding, need-based scholarships were offered for full-time STEM 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 used to increase degree attainment or transfer in STEM fields. Outcomes of these efforts are described, including time elapsed from initial enrollment in the community college to subsequent bachelor's degree attainment. Outcomes by gender, race/ethnicity, and initial mathematics placement of awardees are also provided.

Keywords: time to degree, mentoring, scholarships, transfer rate, underrepresented, STEM

1. INTRODUCTION

The STEM Executive Summary noted that with respect to incomes, "People with an undergraduate major in STEM make substantially more over their lifetimes than non-STEM majors," (Carnevale, Smith, Melton, 2011). Nonetheless, women's bachelor's degree attainment in science and engineering declined in every field from 2004 to 2014. In 2014, women earned 19% of engineering and 18% of computer science bachelor's degrees (Espinosa, 2015). Underrepresented minorities in STEM include African Americans and Hispanic/Latinos. Although African Americans make up 13.2% of the U.S. population, they represent only 4% of engineering bachelor's degree recipients. Similarly, Latinos comprise 17.5% of the U.S. population, but represent only 9% of engineering bachelor's degrees (Chang, 2015).

The National Science Foundation's Division of Undergraduate Education provides a program known as Scholarships for Science, Technology, Engineering, and Mathematics (S-STEM) that can address the underrepresentation described above

(NSF, 2017). This program makes grants to institutions of higher education, which in turn are responsible for selecting scholarship recipients and reporting demographic information about student scholars. Scholarship recipients must be academically talented but financially needy and enrolled full-time in one of these programs: computer and information sciences, engineering, mathematical sciences, biological sciences, physical sciences, geosciences, or technology areas associated with those fields. Individual scholarships cannot exceed \$10,000 per year.

The S-STEM program was preceded by NSF's similar but more restrictive Computer Science, Engineering, and Mathematics Scholarship (CSEMS) program which provided funds to institutions of higher education to select full-time financially needy scholarship recipients from these degree programs: computer science, computer technology, engineering, engineering technology, or mathematics. CSEMS scholarships could not exceed \$3,125 per year.

For both the CSEMS and S-STEM programs, the individual college/university determines award

criteria, including minimum GPA and eligible major programs. However, NSF guidelines specify that students who are awarded these scholarships must be U.S. citizens, permanent residents, nationals, or refugees.

This paper describes long-range degree outcomes for two specific CSEMS and S-STEM scholarship programs at the Community College of Baltimore County. The scope of the paper includes demographics of the combined CCBC awardees, and transfer and graduation rates, for all awardees and certain subgroups of awardees, including by gender, race and ethnicity. Awardees' time elapsed from initial enrollment at this community college to bachelor's degree attainment is also presented.

2. BACKGROUND INFORMATION

The *Time to Degree* research report (Shapiro, Dundar, Wakhungu, Yuan, Nathan & Hwang, 2016) supported by the Lumina Foundation measured time to degree in 2 different ways: elapsed time to degree, and enrolled time to degree. The first measurement (and the one used in this paper) was the time that elapsed between students' first term begin date and the date of degree award. Time elapsed was defined as, "the total time, in calendar years, between initial enrollment in a postsecondary institution and subsequent degree attainment, regardless of whether or not the student was actually enrolled."

In that study, the average elapsed time was 5.7 years for bachelor's degree earners. Those authors found that the average time elapsed to bachelor's degree was extended for students who earned an associate's degree prior to receiving their bachelor's. For students with a prior associate's degree, the time elapsed to a bachelor's degree was 8.2 years. For students without an associate's degree, the time elapsed to bachelor's degree was 5.1 years. Bachelor's degree earners without a prior associate's degree may or may not have also attended a two-year institution. Among bachelor's degree earners with no associate's degree, the average time elapsed to bachelor's degree was 6.0 years for those with prior enrollments in 2-year institutions, and was 4.5 years for those without prior enrollments in 2-year institutions.

The second measurement (called enrolled time, which is not used in this paper) was the actual time in academic years that the student was enrolled full-time (or its full-time equivalent) in postsecondary institutions. (Shapiro et al., 2016)

3. INSTITUTIONAL INFORMATION

The Community College of Baltimore County (CCBC) is a public two-year college system with three campuses serving the greater Baltimore metropolitan area. The Fall 2015 combined credit enrollment was 22,179 students of which 29% were full-time students. Thirty-nine percent (39%) of the credit students were African American, and 60% of credit students were female. The institutional rate of Pell awards provides one indication of the level of unmet financial need. In the 2013-14 academic year, 45% of the credit students at CCBC received a Pell grant. In FY 2015, CCBC awarded 2,200 associate's degrees.

From 2010 to 2015, although CCBC's total fall enrollment steadily declined (falling 16% over that period), enrollment in STEM associate's degree programs increased 43%. Within STEM associate's degree programs at CCBC, the largest enrollment increases occurred in Network Technology (102%), Computer Science (39%), and the new Information Systems Security program which began in 2011. Over that period, there was a 152% increase in the number of STEM associate's degrees awarded at CCBC (MHEC, June 2016a, Nov. 2016). These increases are shown in **Figure 1** (see Appendix).

4. CSEMS AND S-STEM SCHOLARSHIP PROGRAMS AT CCBC

Two Specific Scholarship Programs

One of the CCBC scholarship programs was a CSEMS program, which awarded renewable semester scholarships to 75 (25 female and 50 male) full-time students from Fall 2004 through Fall 2008 (Sorkin, Gore, Mento & Stanton, 2010). The other scholarship program was an S-STEM program, which awarded renewable semester scholarships to 99 (36 female and 63 male) full-time students from Fall 2008 through Fall 2012 (Sorkin, 2013).

CSEMS Project at CCBC

NSF funding for the four-year CSEMS scholarship project, *Promoting Computer Science, Engineering, and Mathematics with Scholarships and Student Support Services*, (DUE-0422225), enabled CCBC to award semester scholarships to a total of 75 students. Award criteria included a minimum 2.5 GPA and readiness for MATH 082 Introductory Algebra, or higher. Computing field associate's degree programs targeted by this project were: 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 E-Business (EBUS) career program was also targeted, along with the Mathematics (MATH) and Engineering (ENGR) transfer programs.

S-STEM Project at CCBC

The NSF-funded four-year project at CCBC, *STEM Scholars Community*, provided renewable scholarships of up to \$10,000 (but not to exceed unmet financial need as determined by FAFSA) per year for full-time students with minimum 2.8 GPA majoring in one of these 7 transfer programs: Biology (BIOL), Chemistry (CHEM), Computer Science (CMSC), Engineering (ENGR), Environmental Science (ENVS), Mathematics (MATH), and Physics (PHYS). Award criteria included readiness for MATH 083 Intermediate Algebra, or higher. A total of 99 students received semester scholarship awards under this program. Awardees were also required to take a MATH course each semester until all mathematics required for their major program was completed. Nine (9) students initially received CSEMS and later received S-STEM scholarships. Duplicate counts are removed from the combined list of awardees shown in **Figure 2**.

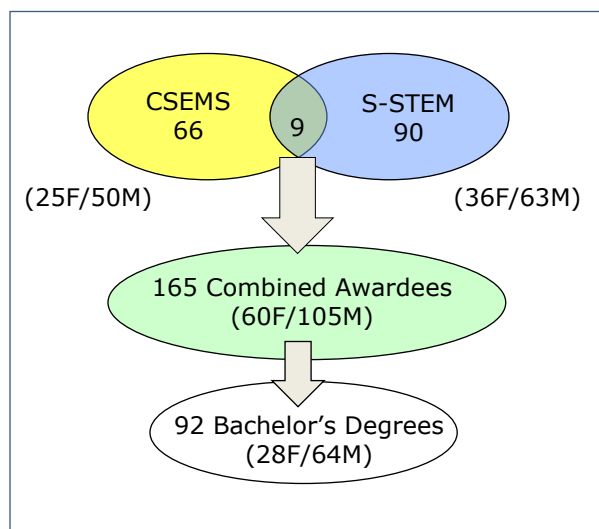


Figure 2. CCBC CSEMS and S-STEM Awardees Combined from Fall 2004 through Fall 2012.

Efforts to Increase the Transfer Rate

Both of these scholarship programs encouraged awardees to continue their STEM studies at four-year institutions. Each project designated a

portion of its scholarship funds to "follow" awardees who transferred and to thereby assist awardees to complete bachelor's degrees in these fields.

Transferring awardees had to provide documentation of their: acceptance and full-time status at the four-year institution in a STEM major; unmet financial need; and successful completion of prior coursework in a STEM degree program at CCBC. Students were given the option of transferring their CSEMS or S-STEM scholarship along with their credits to a four-year institution. This enabled students to reach greater success in a STEM field by drawing attention to the possibility of transfer to a four-year school for students who otherwise might not have considered transfer.

Transfers among Awardees

Thirty-four percent (34%) of the CSEMS semester scholarship awards were made as scholarship renewals to awardees who had earned at least 30 credits at CCBC and were transferring to a 4-year institution. For the S-STEM program, 27% of semester scholarship awards were made to former awardees who had earned an associate's degree, or at least 45 credits, at CCBC before transferring.

5. AWARDEE OUTCOMES

Eighty-seven percent (87%) of the 165 total awardees transferred to a 4-year institution, and an additional 6% earned associate's degrees but did not transfer to a 4-year institution. As shown in **Figure 3**, 55% of the 165 combined awardees earned associate's degrees, 56% earned bachelor's degrees, and 4% earned Doctor of Pharmacy degrees (as of June 2016). And 84% earned at least one of these degrees.

S-STEM Awardee Outcomes by Initial Mathematics Placement Level at CCBC

Students entering CCBC take an *Accuplacer* mathematics placement test which determines their initial mathematics placement. Over half of entering students have an initial mathematics placement that is developmental. That is, the student places into one of the 3 non-credit developmental mathematics courses: MATH 081 Pre-Algebra, MATH 082 Introductory Algebra, or MATH 083 Intermediate Algebra.

S-STEM awardees at CCBC were required to have eligibility for MATH 083 Intermediate Algebra, or higher, at the time of their award. They could obtain this eligibility through their initial mathematics placement, or by completing any

needed developmental mathematics courses. Among the total 99 (36F/63M) CCBC S-STEM awardees from Fall 2008 through Fall 2012 were 37 whose initial mathematics placement level at CCBC was developmental. Although most (30) of these 37 awardees initially placed into MATH 083, there were 4 who initially placed into MATH 082, and 3 who initially placed into MATH 081. The outcomes and success rates for the 37 awardees with initial placement into developmental mathematics, and for the other 62 awardees with initial placement into non-developmental mathematics are shown in **Figure 4**. Among those who initially placed into developmental mathematics, 89% (33/37) transferred to a 4-year institution or graduated with an associate's degree (but did not transfer). Among those whose initial placement was into non-developmental mathematics, 97% (60/62) transferred to a 4-year institution or graduated with an associate's degree. Among the 99 total S-STEM awardees, females formed 35% (13/37) of the developmental initial placement group, and 37% (23/62) of the non-developmental initial mathematics placement group of 99 total awardees.

Awardee Outcomes by Gender

Considering all 165 combined awardees from Fall 2004 through Fall 2012, as of June 2016, a total of 144 awardees (87%) have transferred to 4-year colleges/universities. Overall, 87% (52/60) of the female awardees, and 88% (92/105) of the male awardees have transferred. Bachelor's degrees were earned by 92 awardees (92/165 = 56%), including 47% of female awardees and 61% of male awardees. This is shown in **Figure 5**.

The institutions from which most awardees earned their bachelor's degrees were: 39 from the University of Maryland Baltimore County (UMBC), 11 from Towson University (TU), and 10 from the University of Maryland College Park (UMCP), as well as several other 4-year institutions (most of them public and in-state). Major programs for those 92 who have earned bachelor's degrees are: ENGR (29), IS/IT/Networks (15), BIOL (8), MATH (8), CMSC (5), CHEM (4), PHYS (3), Multimedia (3), and non-STEM programs (17). This is shown in **Figure 6**.

Demographics of CSEMS and S-STEM Awardees

The distribution of all credit students at CCBC in Fall 2012 by racial/ethnic group as self-described at course registration was as follows: white 47%, African American 38%, Asian 5%, Hispanic/Latino 4%, and Other/Unknown 6% (MHEC, June

2016b). Minority groups that have been under-represented in STEM fields nationally are represented among the 165 CSEMS and S-STEM awardees (from Fall 2004 through Fall 2012) in proportions close to their population percentage at CCBC. In particular, 44% of the 165 awardees were white, 30% were African American, 19% were Asian, 4% were Hispanic/Latino, and 2% were Other/Unknown, as shown in **Figure 7**.

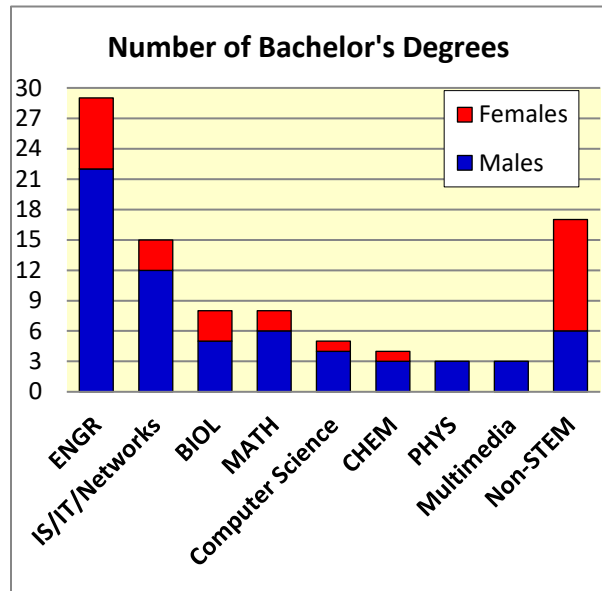


Figure 6. Major Programs for Earned Bachelor's Degrees for 92 CCBC Combined CSEMS and S-STEM Awardees from Fall 2004 through Fall 2012 by Gender.

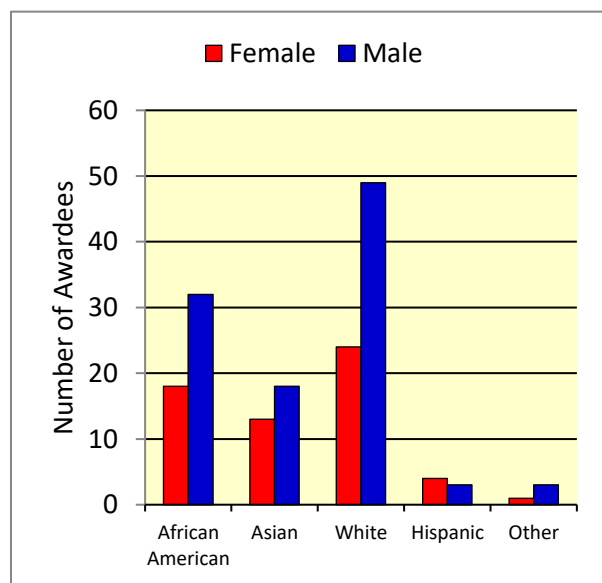


Figure 7. CCBC's 165 CSEMS and S-STEM Awardees from Fall 2004 through Fall 2012 by Race/Ethnicity and Gender.

Awardee Outcomes by Racial/Ethnic Group

As shown in **Figure 8**, although 87% of the 165 combined awardees transferred to a 4-year institution, the transfer rate was higher (94%) among African American awardees, and lower (78%) among white awardees. Although 55% of all awardees earned associate's degrees, 62% of African American awardees, and 62% of white awardees earned associate's degrees. This is shown in **Figure 9**.

Time Elapsed to Bachelor's Degree

The time elapsed to bachelor's degree was determined from awardees' initial entry to CCBC (in months). As shown in **Figure 10**, the median time elapsed was 63 months (5.3 years). The mean time elapsed was 71 months (5.9 years). The distribution of time elapsed to bachelor's degree was skewed to the right. The mean time was affected by awardees who took up to 180 months (15 years) to earn their bachelor's degree, taking time out from coursework at the 4-year institution while working full-time.

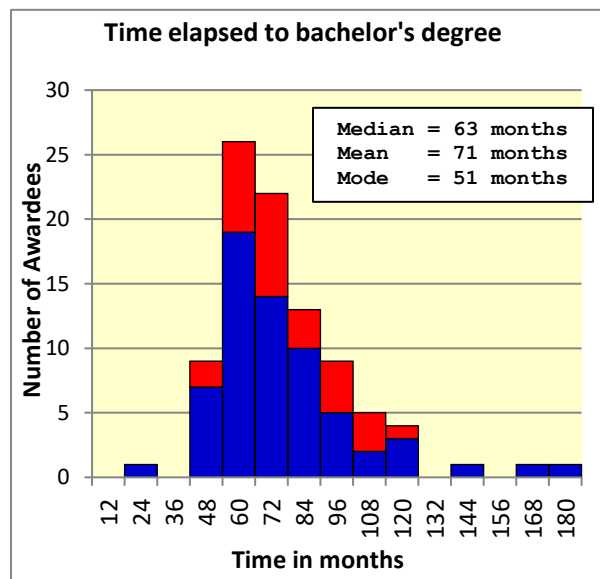


Figure 10. Time Elapsed to Bachelor's Degree from CCBC Entry for 92 CSEMS and S-STEM Awardees from Fall 2004 through Fall 2012 by Gender.

6. CONCLUSIONS

From Fall 2004 through Fall 2012, 165 full-time CCBC students majoring in certain STEM fields received CSEMS or S-STEM scholarships for one or more semesters through NSF funding.

These awardees have been highly successful in graduating with associate's degrees and/or transferring to 4-year institutions where 92 have earned bachelor's degrees.

The transfer rate to 4-year institutions was higher among African American awardees (94% transferred), than among white awardees (78% transferred). African American awardees also had a higher rate (56%) of earning bachelor's degrees than white awardees (49%). Associate's degree attainment was equal (62%) for African American and white awardees.

Awardees with initial developmental and non-developmental mathematics placements were equally likely (49% and 53%) to earn associate's degrees.

Female (87% transferred) and male awardees (88% transferred) were equally likely to transfer to 4-year institutions. Female awardees were 30% more likely to earn associate's degrees than male awardees. Male awardees were 30% more likely to earn bachelor's degrees than female awardees.

Based on these results, for community colleges trying to increase their percentage of students who earn associate's degrees, it seems advisable to focus increased efforts on male students in STEM fields for associate's degree completion. For four-year institutions trying to increase their percentage of transfer students who earn bachelor's degrees in STEM fields, it may be advisable to focus additional efforts on female transfer students for bachelor's degree completion.

Twenty-four percent (24%) of bachelor's degrees earned by awardees were in IS/IT/Networks, Computer Science, and Multimedia major programs combined. Thirty-two percent (32%) of earned bachelor's degrees were in Engineering programs, and 19% were in non-STEM major programs.

Awardees' mean time elapsed to bachelor's degree was 5.9 years, and the median time elapsed to bachelor's degree was 5.3 years, for this group of scholarship awardees.

7. ACKNOWLEDGEMENTS

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Appendices

CCBC Associate's Degree Program	Fall Enrollment in Program Major						Associate Degrees Awarded					
	2010	2011	2012	2013	2014	2015	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
* Science	635	583	551	624	724	746	21	22	27	33	37	44
Engineering	353	391	494	464	413	406	3	7	13	13	9	20
Computer Engineering	0	0	0	0	9	56	0	0	0	0	0	0
Electrical Engineering	0	0	0	0	7	45	0	0	0	0	0	1
Computer Science	340	423	454	415	442	473	7	9	15	14	28	21
Secondary Ed - Chemistry	8	7	10	9	6	2	0	0	0	0	0	0
Secondary Ed - Mathematics	25	33	26	37	30	26	1	0	2	2	0	1
Secondary Ed - Physics	7	3	4	5	4	4	0	0	0	0	0	0
Geospatial Applications	28	25	31	30	29	42	4	3	1	7	9	1
Information Technology	292	306	257	308	283	304	12	21	26	23	39	33
Information Systems Security	0	16	81	140	139	233	0	0	4	8	32	29
Network Technology	191	200	242	435	438	385	27	35	37	34	47	34
Engineering Technology	101	120	111	140	129	117	0	2	5	8	5	5
Totals:	1,980	2,107	2,261	2,607	2,653	2,839	75	99	130	142	206	189
CCBC Total Fall Enrollment and Total Associate's Degrees	26,425	26,271	25,188	24,275	22,887	22,179	1,703	1,854	2,132	2,086	2,020	2,200
%STEM Enrollment and Degrees	7%	8%	9%	11%	12%	13%	4%	5%	6%	7%	10%	9%

*Biology, Chemistry, Environmental Science, Mathematics, and Physics data are included in the Science program.
Sources: MHEC Trends in Enrollment by Program (June 2016), MHEC Trends in Degrees and Certificates by Program (March 2016), MHEC Opening Fall Enrollment (November 2011, December 2012, November 2013, November 2014, November 2015), and MHEC Data Book 2016, 2015, 2014, 2013, 2012, 2011.

Figure 1. CCBC Enrollment and Associate's Degrees Awarded in STEM Programs, 2010 – 2015.

Awardee Outcome	CSEMS Fall 04 – Fall 08		S-STEM Fall 08 – Fall 12		Combined Fall 04 – Fall 12	
	Number of Awardees	% of Awardees	Number of Awardees	% of Awardees	Number of Awardees	% of Awardees
Transferred to 4-yr	65 (21F/44M)	87%	88 (32F/56M)	89%	144 (52F/92M)	87%
Graduated (Associate's degree but no transfer)	5 (2F/3M)	7%	5 (2F/3M)	5%	10 (4F/6M)	6%
Still Enrolled (in community college in 2015)	1 (1F/0M)	1%	1 (0F/1M)	1%	2 (1F/1M)	1%
Dropped Out	4 (1F/3M)	5%	5 (2F/3M)	5%	9 (3F/6M)	5%
TOTALS:	75 (25F/50M)	100%	99 (36F/63M)	100%	165 (60F/105M)	100%
Associate's Degrees:	42 (18F/24M)	56%	51 (22F/29M)	52%	91 (39F/52M)	55%
Bachelor's Degrees:	44 (10F/34M)	59%	57 (19F/38M)	58%	92 (28F/64M)	56%
PharmD Degrees:			6 (4F/2M)	6%	6 (4F/2M)	4%
Earned at least one of these degrees (Associate's, Bachelor's or PharmD):	65 (21F/44M)	87%	82 (30F/52M)	83%	138 (50F/88M)	84%
*Note: 9 students (1F/8M) received CSEMS and subsequently S-STEM awards. They all Transferred and earned Bachelor's degrees. Two of these students (1F/1M) also earned Associate's degrees. Entries in the Combined column eliminate this duplication.						

Figure 3. CCBC CSEMS and S-STEM Awardees and Outcomes (as of 6/6/16) from Fall 2004 through Fall 2012.

Awardee Outcome	Developmental MATH Level		Non-Developmental MATH Level		Combined	
	Number of Awardees	% of Awardees	Number of Awardees	% of Awardees	Number of Awardees	% of Awardees
Transferred to 4-yr	30	81%	58	94%	88	89%
Graduated (Associate's degree but no transfer)	3	8%	2	3%	5	5%
Still Enrolled (in community college in 2015)	1	3%	0	0%	1	1%
Dropped Out	3	8%	2	3%	5	5%
TOTALS:	37 (13F/24M)	100%	62 (23F/39M)	100%	99 (36F/63M)	100%
Associate's Degrees:	18	49%	33	53%	51	52%
Bachelor's Degrees:	19	51%	38	61%	57	58%
PharmD Degrees:	2	5%	4	6%	6	6%

Figure 4. Awardee Outcomes for 99 S-STEM Scholars by Initial Mathematics Placement Level upon Entry to CCBC.

Awardee Outcome	Females		Males		Combined	
	Number of Awardees	% of Awardees	Number of Awardees	% of Awardees	Number of Awardees	% of Awardees
Associate's Degrees:	39	65%	52	50%	91	55%
Transferred to 4-yr	52	87%	92	88%	144	87%
Bachelor's Degrees:	28	47%	64	61%	92	56%
PharmD Degrees:	4	7%	2	2%	6	4%
TOTALS:	60		105		165	

Figure 5. Awardee Outcomes for 165 CCBC CSEMS and S-STEM Scholars by Gender.

Awardee Outcome	Combined Fall 04 – Fall 12 Awardees		Racial/Ethnic Group									
			White		African American		Asian		Hispanic/Latino		Other	
	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees
Transferred to 4-yr	144 (52F/92M)	87%	57 (17F/40M)	78%	47 (17F/30M)	94%	31 (13F/18M)	100%	6 (4F/2M)	86%	3 (1F/2M)	75%
Graduated (Associate’s degree but no transfer)	10 (4F/6M)	6%	9 (4F/5M)	12%	1 (0F/1M)	2%						
Still Enrolled (in community college in 2015)	2 (1F/1M)	1%			2 (1F/1M)	4%						
Dropped Out	9 (3F/6M)	5%	7 (3F/4M)	10%					1 (0F/1M)	14%	1 (0F/1M)	25%
TOTALS:	165 (60F/105M)	100%	73 (24F/49M)	100%	50 (18F/32M)	100%	31 (13F/18M)	100%	7 (4F/3M)	100%	4 (1F/3M)	100%
% Female in that Racial/Ethnic Group:	60/165	36%	24/73	33%	18/50	36%	13/31	42%	4/7	57%	1/4	25%

Figure 8. Awardee Outcomes for 165 CCBC CSEMS and S-STEM Scholars by Racial/Ethnic Group.

Awardee Degree Outcome	Combined Fall 04 – Fall 12 Awardees		Racial/Ethnic Group									
			White		African American		Asian		Hispanic/Latino		Other	
	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees	Number of Awardees	% of Award-ees
Associate’s Degrees:	91 (39F/52M)	55%	45 (16F/29M)	62%	31 (14F/17M)	62%	11 (7F/4M)	35%	3 (2F/1M)	43%	1 (0F/1M)	25%
Bachelor’s Degrees:	92 (28F/64M)	56%	36 (8F/28M)	49%	28 (9F/19M)	56%	22 (7F/15M)	71%	5 (3F/2M)	71%	1 (1F/0M)	25%
PharmD Degrees:	6 (4F/2M)	4%	1 (0F/1M)	1%	3 (2F/1M)	6%	2 (1F/1M)	6%				
Earned at least one of these degrees (Associate’s, Bachelor’s or PharmD):	138 (50F/88M)	84%	62 (20F/42M)	85%	43 (16F/27M)	86%	26 (10F/16M)	84%	5 (3F/2M)	71%	2 (1F/1M)	50%
TOTALS:	165 (60F/105M)	100%	73 (24F/49M)	44%	50 (18F/32M)	30%	31 (13F/18M)	19%	7 (4F/3M)	4%	4 (1F/3M)	2%

Figure 9. Degree Outcomes for 165 CCBC CSEMS and S-STEM Scholars by Racial/Ethnic Group