



DIVERSIFYING STEM: STUDENT SUCCESS AND COMMUNITY COLLEGE TRANSFER IN ENGINEERING AND COMPUTER SCIENCE IN TEXAS

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Roberta M. Rincon, Ph.D.
Society of Women Engineers

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TABLE OF CONTENTS

Introduction	6
Definition of Key Terms and Measures	9
Major Findings.....	10
Data and Methodology.....	12
Though Few Women Choose an ECS Major, Women are Increasingly Persisting and Graduating in ECS.....	13
Black and Hispanic Women are Least Likely To Declare an ECS Major	14
Women’s Persistence and Completion In ECS Is Increasing.....	15
Racial Gaps Exist In Persistence and Completion In ECS For Both Genders	17
More Women Than Men Switch Out Of ECS and Into a Non-ECS Major at almost Every Public Two-Year and Four-Year College In Texas	20
Few Transfer Students Declare an ECS Major, but Many Who Do are Earning ECS Baccalaureate Degrees	23
Women Who Transfer to a Four-Year University and Declare an ECS Major are Seeing Higher ECS Baccalaureate Degree Completion Rates Than Men.....	24
Larger Racial/Ethnic Gaps In ECS Baccalaureate Degree Completion are Seen among Men Than Women	26
Across all Two-Year Community Colleges, More Men Than Women Transfer and Complete ECS Baccalaureate Degrees	27
Conclusion	29
Recommendations.....	32
Next Steps.....	34
References	35
Appendix A: Engineering and Computer Science Disciplines Categorized as ECS.....	38

FIGURES

Figure 1. Percentage of Students Who Declared an ECS Major, by Gender and FTIC Cohort	7
Figure 2. Gender Distribution of Declared ECS Majors and Total ECS Enrollment, by FTIC Cohort.....	8
Figure 3. 2011/12 FTIC Cohort Declaring an ECS Major, by Gender and Race/Ethnicity	8
Figure 4. Persistence Rates Of Students Majoring In ECS, 2002/03 To 2010/11 FTIC Cohorts, by Gender	10
Figure 5. Number Of ECS Majors Who Earned an ECS Baccalaureate Degree by Fall 2015, by Gender and FTIC Cohort	10
Figure 6. ECS Majors Who Earned a Baccalaureate Degree by Fall 2015, by Gender, FTIC Cohort, and ECS Vs. Non-ECS Degree.....	11
Figure 7. Persistence and Completion Rates Of Male ECS Majors, 2002/03 and 2010/11 FTIC Cohorts, by Race/Ethnicity	12
Figure 8. Persistence and Completion Rates Of Female ECS Majors, 2002/03 and 2010/11 FTIC Cohorts, by Race/Ethnicity	13
Figure 9. Comparison Of The Percentage Of Male and Female Students Who Switched From an ECS Major To a Non-ECS Major, by Four-Year Institution, 2002/03 To 2011/12 FTIC Cohorts	15
Figure 10. Comparison Of The Percentage Of Male and Female Students Who Switched From an ECS Major To a Non-ECS Major, by Two-Year Institution, 2002/03 To 2011/12 FTIC Cohorts	16
Figure 11. Number Of Transfer Students From 2-Year To 4-Year Institutions, all Majors, by Gender, 2002/03 To 2010/11 FTIC Cohorts	17
Figure 12. Percentage Of Transfer Students Who Declared an ECS Major, by Gender, 2002/03 To 2010/11 FTIC Cohorts	18
Figure 13. Percentage Of Transfer Students Who Declared an ECS Major and Graduated with an ECS Baccalaureate Degree by 2015, by Gender and FTIC Cohort	19
Figure 14. Percentage Of Transfer Students (all Majors) Who Earned an ECS Baccalaureate Degree by 2015 From The 2002/03 To 2011/12 FTIC Cohorts, by Gender and Race/Ethnicity	20
Figure 15. Total Number Of Transfer Students Who Earned an ECS Baccalaureate Degree by 2015 From The 2002/03 To 2011/12 FTIC Cohorts, by Gender and Sending Two-Year College	21

TABLES

Table 1. Number of Male and Female ECS Majors who Earned an ECS Baccalaureate Degree by 2015, 2002/03 And 2010/11 FTIC Cohorts, by Race/Ethnicity.....	14
Table 2. Number of Transfer Students Who Earned an ECS Baccalaureate Degree by 2015, by Gender And FTIC Cohort.....	20

INTRODUCTION

“Community colleges are an increasingly popular route toward a baccalaureate degree, offering open enrollment policies, flexible schedules, and opportunities to address gaps in academic preparation.”

Community colleges provide a practical postsecondary option for many students interested in earning a higher education credential, but who are in need of a lower-cost, flexible alternative to a traditional four-year university program. Among the almost 18 million undergraduates in the U.S., 25 percent are older than 25 years of age, and approximately 40 percent work at least 30 hours per week.¹ Almost 40 percent of undergraduates in the U.S. attended a public two-year college in 2015-16.²

Community college is a particularly popular pathway for underrepresented minority students, who are overrepresented among community college student enrollments.³ In 2012, approximately 56 percent of Hispanic undergraduates, 53 percent of American Indian/Alaskan Native undergraduates, and 49 percent of Black undergraduates were enrolled in community colleges across the United States.⁴ Among women, 44 percent of undergraduate students were enrolled in community colleges in 2012.⁵ Notably, over 80 percent of first-time community college students indicate that they want to complete their bachelor's degree or higher.⁶

The community college pathway toward an engineering and computer science (ECS) baccalaureate degree has the potential to help us increase the diversity of the ECS fields, given that:

- Approximately 15 percent of two-year college students declare a major in engineering or computer science,⁷
- Over 65 percent of students who declare an engineering major and transfer to a four-year university eventually complete an engineering baccalaureate degree,⁸ and
- Many underrepresented groups (including women and minorities) begin their education at a community college.

Unfortunately, only 33 percent of community college students, regardless of major, successfully transfer.⁹

¹ Carnevale, A. P., Smith, N., Melton, M., & Price, E. W. (2015). *Learning while earning: The new normal 2015*.

² U.S. Department of Education. National Center for Education Statistics. (2017). *NCES 2017-075*.

³ Bailey, T. (2012). Can community colleges achieve ambitious graduation goals?

⁴ U.S. Department of Education, Spring 2016, Fall Enrollment component.

⁵ Ibid.

⁶ Horn, L., & Skomsvold, P. (2011). *Web tables: Community college student outcomes: 1994–2009*.

⁷ U.S. Department of Education. National Center for Education Statistics. (2014). *NCES 2014-001*.

⁸ Burke, R. J. & Mattis, M. C. (2007). Women and minorities in science, technology, engineering, and mathematics: Upping the numbers.

⁹ Jenkins, D. & Fink, J. (2016). Tracking transfer: New measures of institutional and state effectiveness in helping community college students attain bachelor's degrees.

The purpose of this report is to understand the success of students who choose to pursue an ECS baccalaureate degree and begin their postsecondary education at a community college. The report begins with an overview of the persistence and baccalaureate completion rates of students who declare an ECS major in Texas, at both two-year and four-year colleges, disaggregating the data by gender and race to highlight gaps that are often masked when looking at STEM as a whole. The report then presents data on the transfer success of students in ECS in Texas. Texas was chosen as the focus of this report because of ease of access to student-level transfer data, the diversity of the population, and the fact that the majority of bachelor's degree earners in the state had prior enrollment in a two-year community college.¹⁰

Community college students are often excluded from conversations surrounding broadening participation in STEM – particularly in ECS fields, where they are significantly underrepresented. This report presents data to show that, despite efforts to improve transfer success and increase diversity in STEM in Texas, we have not seen significant gains in successful transfer and ECS baccalaureate degree completion among students who begin at a two-year college. Though we cannot extrapolate the findings of this study to a national scale, they offer insight into a student population that is largely overlooked. Considering the underrepresentation of women and minorities in STEM, coupled with the need to better support students who choose to pursue a STEM baccalaureate degree and start at a two-year college, more attention must be devoted to ensuring the success of these students to promote increasing diversity in STEM fields.^{11,12}

DEFINITION OF KEY TERMS AND MEASURES

The following terms and measures were used for this report.

Completion of an ECS Degree

Students who earned an ECS baccalaureate degree by Fall 2015 (the last semester of available data) were included in totals and percentages of students who reached completion, regardless of the amount of time taken to complete the degree. For this study, completion is reported by first-time-in-college (FTIC) cohort. Completion data reported for later cohorts will be low because students in these cohorts have had less time to complete their degrees than earlier cohorts.

Engineering and Computer Science Majors

The Classification of Instructional Programs (CIP) from the National Center for Education Statistics (NCES) was used to identify ECS majors for inclusion in this study. Eligible majors were selected using the following criteria:

- Majors affiliated with a baccalaureate degree
- Selected majors in CIP code families 11 (Computer and Information Sciences and Support Services), 14 (Engineering), 15 (Engineering Technologies and Engineering-Related Fields), and 30 (Multi/Interdisciplinary Studies).

A full list of included ECS majors can be found in Appendix A.

¹⁰ National Student Clearinghouse Research Center. (2017). *Snapshot report – Contribution of two-year public institutions to bachelor's completions at four-year institutions*.

¹¹ Yoder, B.L. (2017). *Engineering by the numbers, 2016*.

¹² Bureau of Labor Statistics: U.S. Department of Labor (2016). *Employed persons by detailed occupation, sex, race, and Hispanic or Latino ethnicity*.

First-Time-In-College Cohorts

Degree-seeking students were assigned to first-time-in-college (FTIC) cohorts based on the year they first entered college. Ten FTIC cohorts are included in this report (2002/03 through 2011/12). FTIC assignment is based on enrollment in the leading summer (e.g., Summer 2002), fall (e.g., Fall 2002), or spring (e.g., Spring 2003) semester of a given school year, regardless of part-time or full-time status. High school students enrolled in dual credit courses are not included in an FTIC cohort until after high school graduation.

Persistence in an ECS Major

Students who declared an ECS major and either earned an ECS baccalaureate degree by Fall 2015 (the last semester of available data) or remained enrolled in an ECS major as of Fall 2015 were considered to have persisted in ECS.

Student Transfer

For the purposes of this report, students are considered transfers when they transfer from a two-year college to a four-year university in a subsequent semester. The transfer from a two-year college to a four-year university does not have to be in consecutive semesters, and students' first institution type of enrollment did not have to be a two-year college (i.e., students who reverse transferred from a four-year university to a two-year college, then transferred back to a four-year university are classified as transfers). Unless otherwise specified, only public two-year and four-year universities are included in this report.

Switching Majors

For the purposes of this report, only major switches from an ECS major to a non-ECS major are considered. Only the outcome associated with students' first major switch is presented.

MAJOR FINDINGS

The following are some of the major findings from this descriptive analysis of student enrollment, transfer, persistence, and baccalaureate degree attainment in ECS in Texas.

Declaration of an ECS Major

Despite the fact that more women than men enroll in college each year, **less than 4 percent of female students choose to major in ECS** compared to almost 20 percent of men across all two-year and four-year colleges. **The percentage of women among students who declare an ECS major has slightly decreased over time**, from 20.2 percent in the 2002/03 FTIC cohort to 17.8 percent in the 2011/12 FTIC cohort. **Less than 4 percent of White, Hispanic, and Black female students declared an ECS major** in the 2010/11 FTIC cohort, compared to 8 percent of Asian female students. Only 15 percent of Black male students in the 2010/11 FTIC cohort declared an ECS major, compared to over 28 percent of Asian male students. Over the course of the ten FTIC cohorts analyzed, **Black and Hispanic students of both genders experienced slight decreases** in the percentage of students choosing to major in ECS.

Persistence and Completion Rates in ECS

Women's persistence rates in ECS have risen almost 12 percent since the 2002/03 FTIC cohort, far outpacing the 3 percent increase in persistence that men have experienced over this same time. However, **less than 30 percent of students who declared an ECS major at a public institution in Texas had persisted** in ECS by 2015. **A higher percentage of women than men completed an ECS baccalaureate degree** from the 2008/09 FTIC cohort – a reversal from prior cohort years. However, **women are switching out of ECS and earning a non-ECS baccalaureate degree at higher rates than men**. Persistence and completion rates of ECS students by FTIC cohort were lowest among Black and Hispanic students, regardless of gender. **Asian students of both genders have the highest ECS baccalaureate degree completion rates, while Black students have the lowest**. Female ECS degree attainment has increased overall, but success has been concentrated among White females. Hispanic

and Asian women have seen slight increases, while **Black females have seen a decrease in ECS degree completion rates**. More women than men switch out of ECS and into a non-ECS major at both two-year and four-year colleges, but major switching rates are high for both genders. **Seven two-year colleges and six four-year universities in Texas saw over half of female ECS students switch to non-ECS majors**. Only one four-year university experienced such high switching rates among male ECS students.

Transfer Success in ECS

Irrespective of major choice, more women than men transfer from a two-year college to a four-year university. For students who transfer from a two-year college to a four-year university, **less than 2 percent of female students select an ECS major**, compared to 11 percent of male students. **ECS baccalaureate completion rates among transfer students exceeded 60 percent for men and 50 percent for women** from the 2005/06 FTIC cohort, the highest in this study. Female transfer students in ECS began seeing higher ECS baccalaureate completion rates than male students in later cohorts. Male transfer graduates in ECS consistently outnumber female transfer graduates for every cohort year included in this study, but **male students are experiencing declines** in transfers and degree completions. **Less than 1 percent of all Black, Hispanic, and White female transfer students across all FTIC cohorts earned an ECS baccalaureate degree by Fall 2015**. Approximately 7 percent of White male transfer students earned an ECS baccalaureate degree by Fall 2015, more than double the rate of ECS degree attainment among Black male transfer students. Over 60 percent two-year colleges (sending institutions) included in this analysis had more than 100 male transfer graduates in ECS by Fall 2015, compared to only 3 percent that had more than 100 female transfer graduates in ECS.

DATA AND METHODOLOGY

Public two-year colleges and four-year universities in Texas are required to report student-level data to the Texas Higher Education Coordinating Board. Enrollment data, major selection, and student demographic information are reported each semester, while graduation data are reported annually. Longitudinal datasets beginning with the 2002/03 school year are made available to researchers through the Texas Education Research Center housed at The University of Texas at Austin. The Texas Education Research Center imposes strict requirements on the release of data and results from the Center to ensure the confidentiality of student data; hence, this report includes disaggregated data by gender and race/ethnicity when sufficient numbers of students were available for a given outcome.

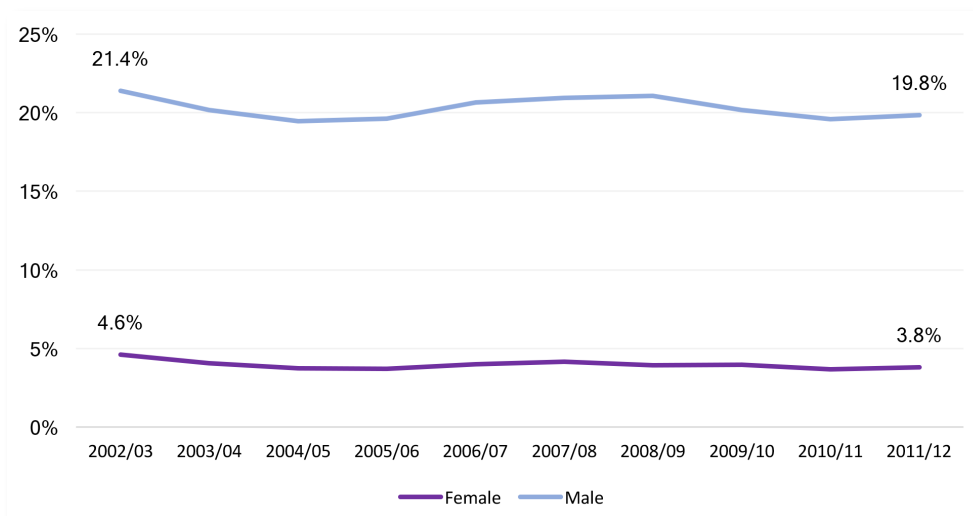
This descriptive study was intended to analyze the transfer success of underrepresented students in ECS in Texas, with particular attention given to women of color. However, extremely low student counts in female subpopulations resulted in data suppression to ensure student privacy. As a result, the scope was expanded to include the success of women and underrepresented minorities who choose to major in ECS, regardless of the type of institution they first enrolled in (two-year college or four-year university), but focusing on transfer student success and disaggregated subpopulations as data availability permitted. All analyses are disaggregated by FTIC cohort where allowed, and are collapsed across cohorts when required to avoid data suppression.

THOUGH FEW WOMEN CHOOSE AN ECS MAJOR, WOMEN ARE INCREASINGLY PERSISTING AND GRADUATING IN ECS

Interest in pursuing an ECS degree is growing among both men and women, but recent data show that female freshmen entering college in the U.S. still have significantly lower rates of interest in majoring in ECS than male freshmen, with only 8 percent of female freshmen intending to major in engineering, math, statistics, or computer science compared to 27 percent of male freshmen.¹³

College enrollments in Texas mirror those of the nation, where over half of undergraduates are women, but far more men than women declare an ECS major. The difference between the percentage of men and women who enter a two-year or a four-year institution and declare a major in ECS remains large (Figure 1). This difference results in a disproportionate number of male students in ECS compared to female students: less than 4 percent of female students in the 2011/12 FTIC cohort declared an ECS major in the state of Texas, compared to almost 20 percent of men.

Figure 1. Percentage of Students Who Declared an ECS Major, by Gender and FTIC Cohort



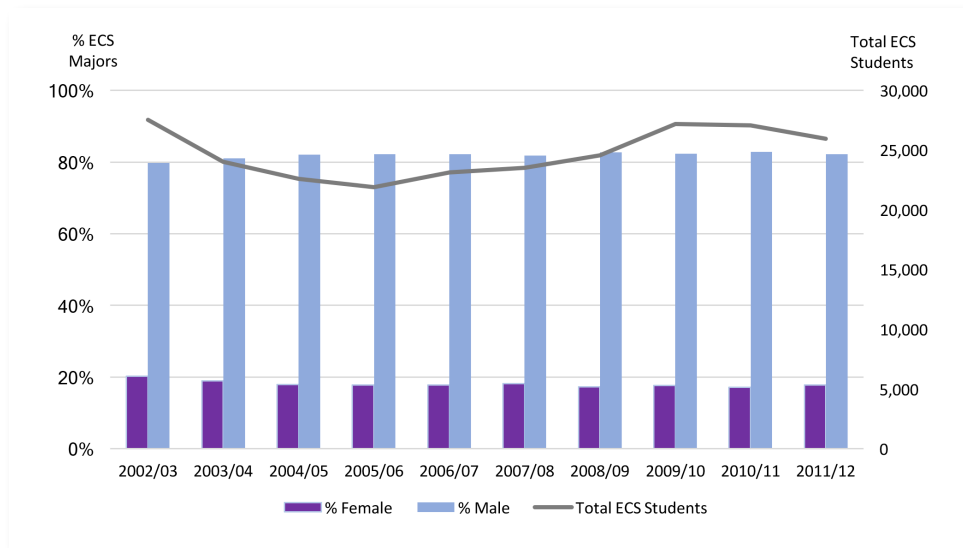
Note: Data regarding major declaration was available through fall 2015. Students in more recent cohorts (e.g., the 2010/11 or 2011/12 cohort) had less time to declare an ECS major than students who were members of earlier cohorts (e.g., 2002/03). Includes all public two-year and four-year enrollees.

Source: Texas Higher Education Coordinating Board CBM001 reports, 2002/03 to 2015/16.

¹³ National Science Foundation. (2016). Science and engineering indicators 2016.

Students declaring an ECS major from all public higher education institutions in Texas between 2002/03 to 2011/12 ranged from a low of approximately 22,000 to over 27,000 students each year. During this same time, male students accounted for approximately 80 percent of students declaring ECS majors across two-year and four-year institutions, while female students accounted for approximately 20 percent of students in ECS (Figure 2). Women’s proportion of ECS major declarations has decreased slightly during this period, even as the number of students declaring an ECS majors fluctuated, with only 17.8 percent of female students in the 2011/12 FTIC cohort declaring an ECS major, down from a high of 20.2 percent in the 2002/03 FTIC cohort.

Figure 2. Gender Distribution of Declared ECS Majors and Total ECS Enrollment, by FTIC Cohort



Note: Data regarding major declaration was available through fall 2015. Students in more recent cohorts (e.g., the 2010/11 or 2011/12 cohort) had less time to declare an ECS major than students who were members of earlier cohorts (e.g., 2002/03). Includes all public two-year and four-year enrollees.

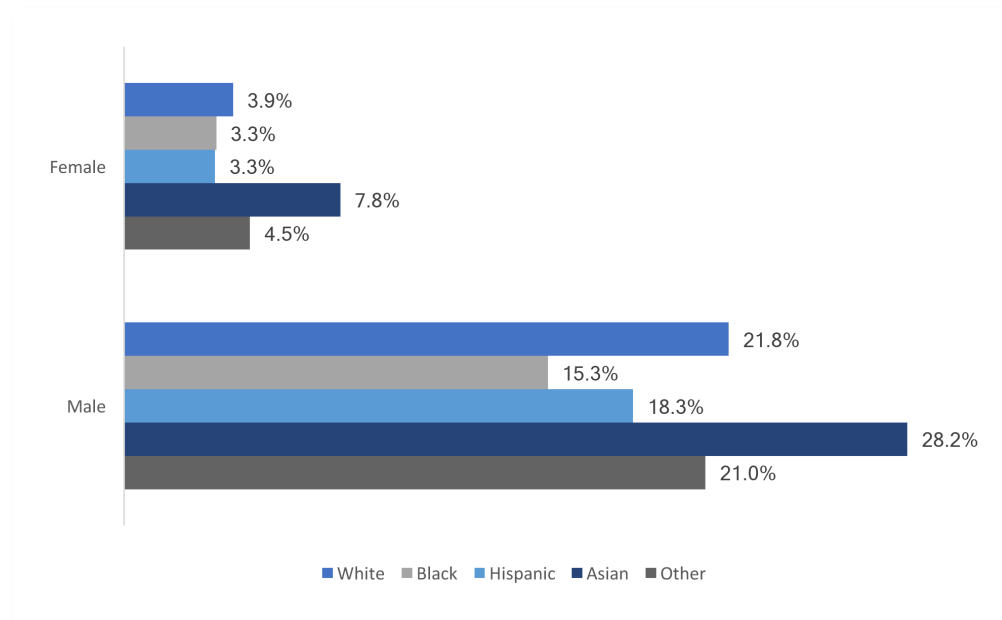
Source: Texas Higher Education Coordinating Board CBM001 reports, 2002/03 to 2015/16.

Black and Hispanic Women Are Least Likely to Declare an ECS Major

Low degree attainment in ECS among minority women is unsurprising given the low number of minority women who choose to major in ECS. In Texas, the percentage of female students declaring an ECS major is significantly lower than male students. Among women, Asian women are the most likely to declare an ECS major, but less than 8 percent of Asian women in the 2010/11 FTIC cohort chose an ECS major (Figure 3). Among White, Hispanic, and Black female students, less than 4 percent declared an ECS major in the 2010/11 FTIC cohort. This is in stark contrast to male students, with almost 22 percent of White male students and more than 28 percent of Asian male students declaring an ECS major.

Across all FTIC cohorts in this study, Asian male students were the most likely to declare an ECS major than any other race/ethnicity group. Over the course of the ten FTIC cohorts analyzed, Black and Hispanic students of both genders experienced slight decreases in the percentage of students choosing to major in ECS.

Figure 3. 2011/12 FTIC Cohort Declaring an ECS Major, by Gender and Race/Ethnicity



Note: Data regarding major declaration was available through fall 2015. Students in more recent cohorts (e.g., the 2010/11 or 2011/12 cohort) had less time to declare an ECS major than students who were members of earlier cohorts (e.g., 2002/03). Includes all public two-year and four-year enrollees.

Source: Texas Higher Education Coordinating Board CBM001 reports, 2002/03 to 2015/16.

Women's Persistence and Completion in ECS Is Increasing

Less than 30 percent of students from the 2010/11 FTIC cohort who declared an ECS major at a public institution in Texas had persisted in an ECS major by 2015 (graduated with an ECS baccalaureate degree or were still enrolled in an ECS major – Figure 4). The 2010/11 FTIC cohort was the first year in which women's persistence rates exceeded those of men, at 29.6 percent versus 27.5 percent, respectively. Women's persistence rates in ECS have risen almost 12 percent since the 2002/03 FTIC cohort, far outpacing the 3 percent increase in persistence rates that men have experienced over this same time.

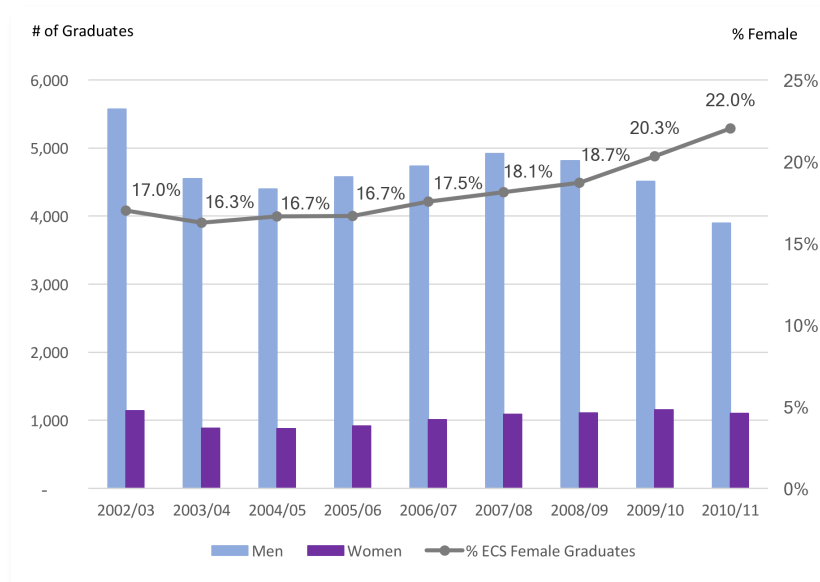
Focusing on the ECS degrees earned by FTIC cohort rather than degrees awarded per year provides a different perspective of student success in ECS. While the percentage of ECS baccalaureate degrees earned by women each year at the national level has remained relatively unchanged over the last 10 years, hovering around 18 percent despite a growth in total degrees earned, a look at the FTIC cohorts in Texas shows that the proportion of degrees earned by women is actually increasing (Figure 5). Unfortunately, this trend appears to be partially driven by fluctuations in the number of men earning ECS degrees.

Until the 2008/09 FTIC cohort, men were more likely than women to complete an ECS baccalaureate degree, while women who had declared an ECS major at some point were more likely to earn a non-ECS baccalaureate degree (Figure 6). Though care should be taken when comparing against earlier cohorts because latter cohorts have had less time to complete their degrees, it is clear that more women who declare an ECS major are graduating with ECS baccalaureate degrees than in prior years. Women who declare an ECS major are increasingly earning degrees in ECS, but women are still switching out of ECS and earning non-ECS baccalaureate degrees at higher rates than men. Almost 16 percent of women from the 2008/09 FTIC cohort who at some point had declared an ECS major ended up earning a non-ECS degree, compared to 10 percent of men. For both genders, these percentages are decreasing.

Figure 4. Persistence Rates of Students Majoring in ECS, 2002/03 to 2010/11 FTIC Cohorts, by Gender



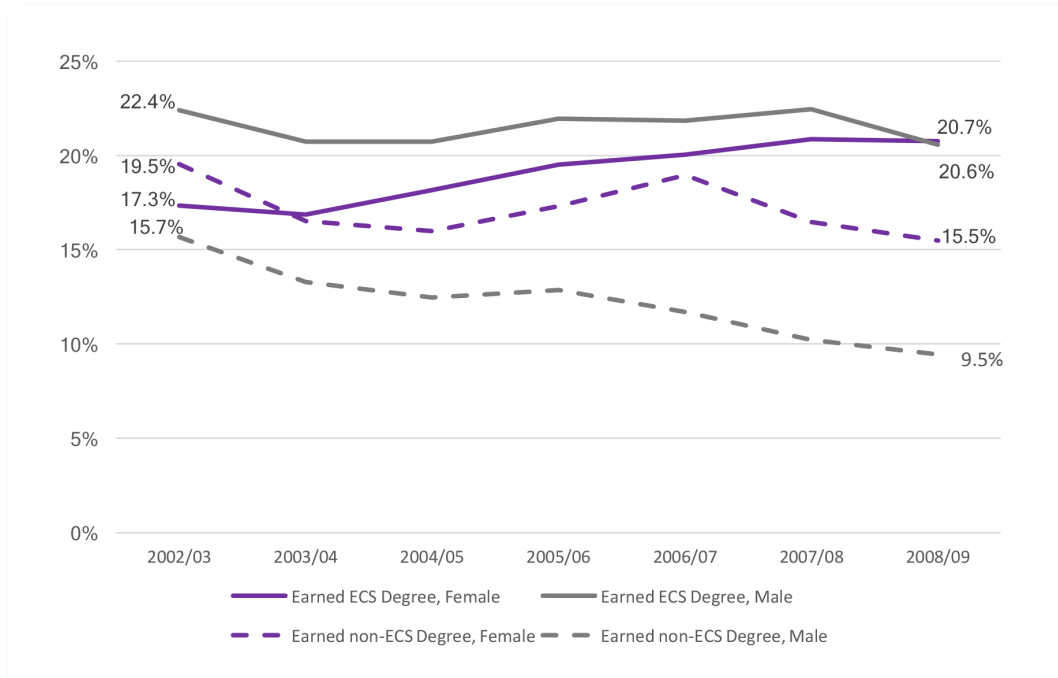
Figure 5. Number of ECS Majors Who Earned an ECS Baccalaureate Degree by Fall 2015, by Gender and FTIC Cohort



Note: Includes all public two-year and four-year enrollees who ever declared an ECS major between the 2002/03 school year and spring of the 2014/15 school year.

Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

Figure 6. ECS Majors Who Earned a Baccalaureate Degree by Fall 2015, by Gender, FTIC Cohort, and ECS vs. Non-ECS Degree



Note: Includes all public two-year and four-year enrollees who ever declared an ECS major between the 2002/03 school year and spring of the 2014/15 school year.

Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

Racial Gaps Exist in Persistence and Completion in ECS for Both Genders

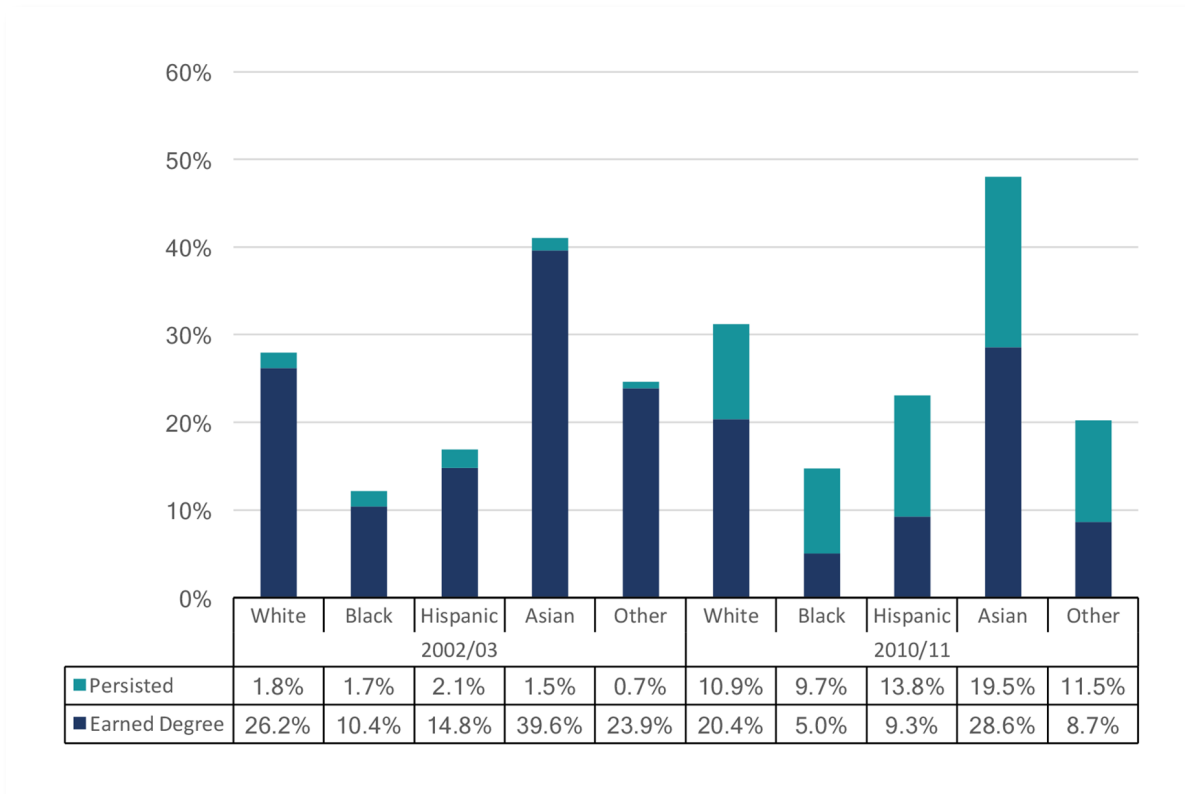
In 2014, less than 6 percent of engineering bachelor’s degrees and 7 percent of computer science bachelor’s degrees were awarded to Black, Hispanic, and Asian women combined in the U.S.¹⁴ At a national level, Asian and Hispanic women are seeing slow increases in baccalaureate degree attainment in ECS, but Black women are experiencing declines.¹⁵

¹⁴ National Science Foundation, National Center for Science and Engineering Statistics. (2017). *Women, minorities, and persons with disabilities in science and engineering*.

¹⁵ Slaughter, J. B., Tao, Y., & Pearson, W. (2015). *Changing the face of engineering: The African American experience*.

Reflecting the national trends, persistence and completion rates of ECS students by FTIC cohort in Texas were lowest among Black and Hispanic students, regardless of gender. For the 2010/11 FTIC cohort, Black and Hispanic ECS baccalaureate degree completion rates were less than half of White students and approximately one-third of Asian students. Among male ECS students, 26 percent of White students and 40 percent of Asian students from the 2002/03 FTIC cohort had completed their ECS degrees by 2015, compared to 10 percent of Black students and 15 percent of Hispanic students (Figure 7). While completion rates were lower for men across all racial and ethnic groups for the 2010/11 FTIC cohort, a large number of students were still enrolled and pursuing an ECS baccalaureate degree.

Figure 7. Persistence and Completion Rates of Male ECS Majors, 2002/03 and 2010/11 FTIC Cohorts, by Race/Ethnicity

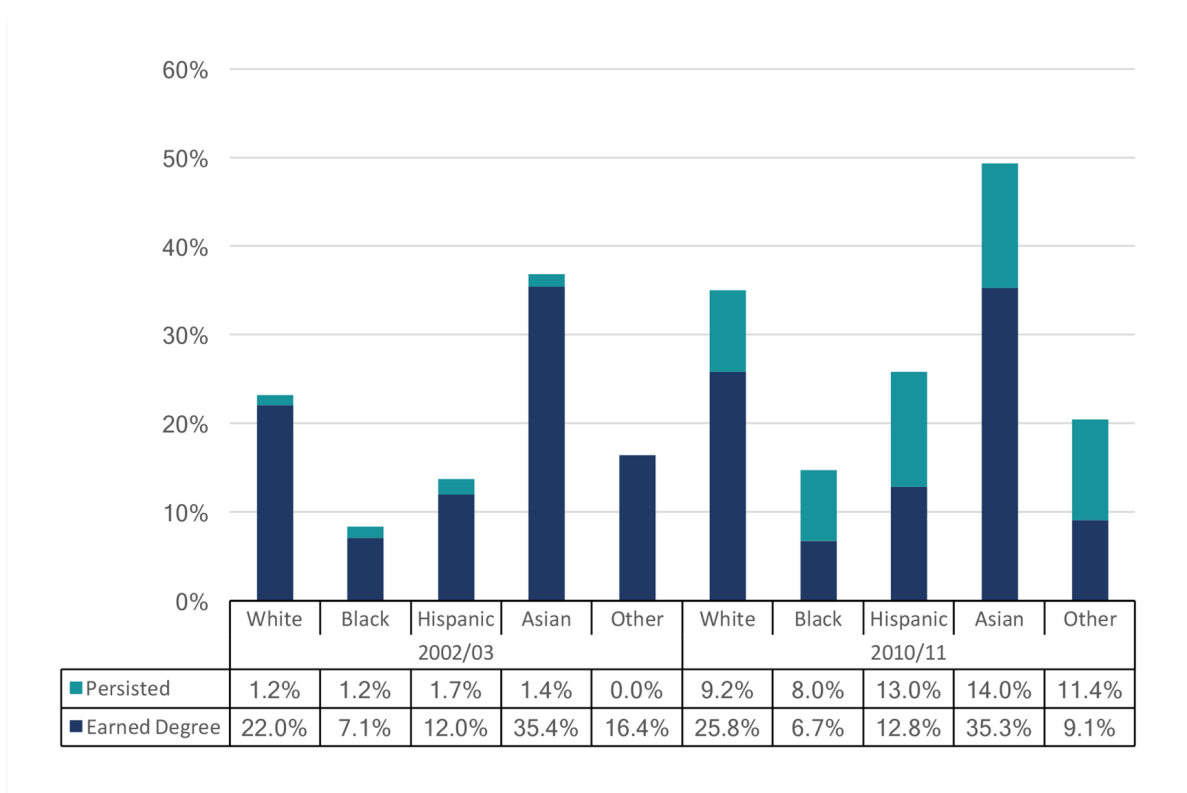


Note: Includes all public two-year and four-year enrollees who ever declared an ECS major between the 2002/03 school year and spring of the 2014/15 school year. Completion rate is determined by Fall 2015.

Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

For female students majoring in ECS, White and Hispanic students saw an increase in the percentage of women earning ECS baccalaureate degrees from the 2002/03 to the 2010/11 FTIC cohorts, while Asian women saw little difference (Figure 8). Black women saw a slight decrease in their completion rates, but all racial and ethnic groups had significantly more women still enrolled in ECS and working toward their degrees from the 2010/11 FTIC cohort than in the 2002/03 FTIC cohort. Women had higher degree completion rates from the 2010/11 FTIC cohort compared to men of the same race/ethnicity from the same cohort.

Figure 8. Persistence and Completion Rates of Female ECS Majors, 2002/03 and 2010/11 FTIC Cohorts, by Race/Ethnicity



Note: Includes all public two-year and four-year enrollees who ever declared an ECS major between the 2002/03 school year and spring of the 2014/15 school year. Completion rate is determined by Fall 2015.

Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

While percentages can show positive and negative trends in student success by FTIC cohort, it is important to keep in mind the actual number of students within each group, by gender and race/ethnicity. Table 1 lists the headcount by gender and race/ethnicity of the students who declared an ECS major and earned an ECS degree from the 2002/03 FTIC cohort and the 2010/11 FTIC cohort. It is clear to see that female degree attainment has increased significantly overall. However, Black females have seen a decrease, and given their low counts, this is particularly concerning. Hispanic and Asian women have seen slight increases over time.

Table 1. Number of Male and Female ECS Majors Who Earned an ECS Baccalaureate Degree by 2015, 2002/03 and 2010/11 FTIC Cohorts, by Race/Ethnicity

	White	Black	Hispanic	Asian	Other	Total
2002/03						
Female	545	63	192	124	42	966
Male	3,072	224	853	540	235	4,924
2010/11						
Female	426	48	205	136	27	842
Male	1,835	131	711	448	139	3,264

Note: Includes all public two-year and four-year enrollees who ever declared an ECS major between the 2002/03 school year and spring of the 2014/15 school year.

Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

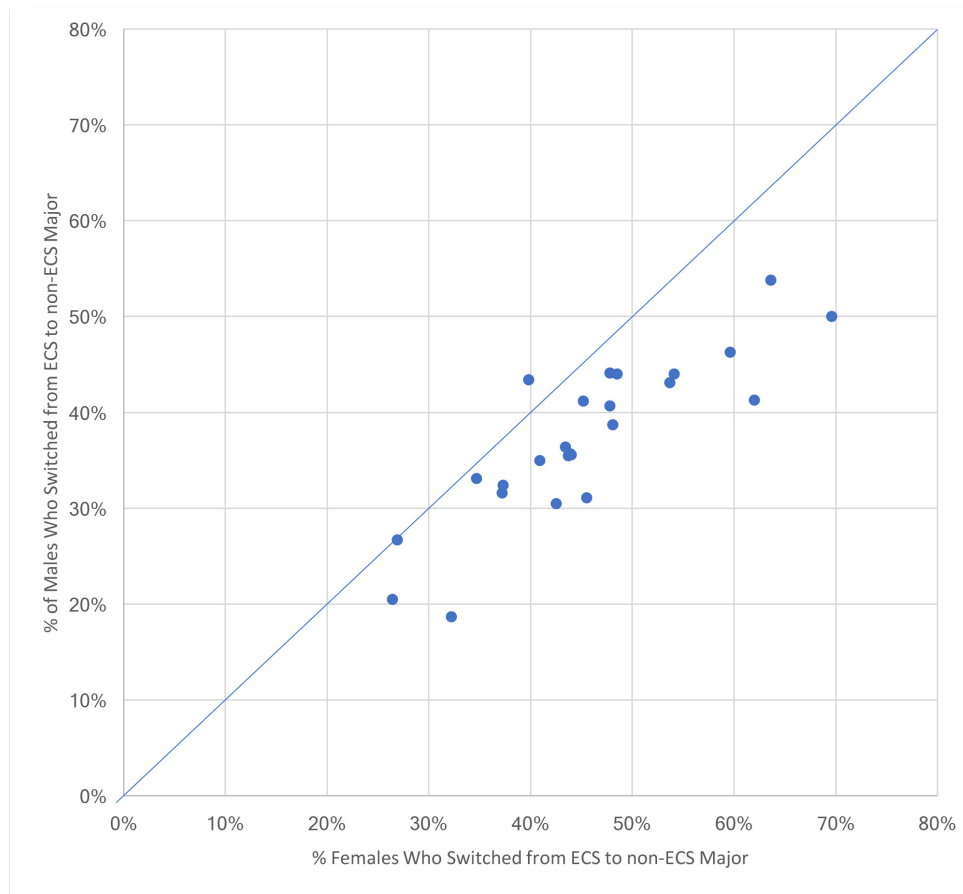
What is most surprising is the rate of male degree attainment compared to women over this same time period. When looking at the actual headcounts, it appears that either men are taking longer to earn their degrees than women or they are not earning them at all. Given the data shown in Figure 6, which shows a decreasing percentage of men who declare an ECS major but graduate with a non-ECS degree, the latter may actually be the case.

More Women than Men Switch out of ECS and into a Non-ECS Major at Almost Every Public Two-Year and Four-Year College in Texas

Across the state of Texas, one finding was relatively consistent regardless of whether a student first enrolled at a two-year college or four-year university: a high percentage of students who declare an ECS major switch to a non-ECS major, across both genders. Institutions with high major switching among women also tend to have high major switching among men, though this was much more consistently the case for students who first declared an ECS major at four-year universities (Figure 9) than those at two-year community colleges (Figure 10). In both figures, the blue line indicates “equal switching by gender,” so an institution that falls on the line would have the same rate of major switching from ECS to non-ECS for both male and female students who declared an ECS major at that institution. Points that fall below the line indicate institutions with more female than male major switchers, and the farther away from the line the points are, the greater the gap between genders.

Figure 9. Comparison of the Percentage of Male and Female Students Who Switched from an ECS Major to a Non-ECS Major, by Four-Year Institution, 2002/03 to 2011/12 FTIC Cohorts

Each Point Represents a Four-Year University

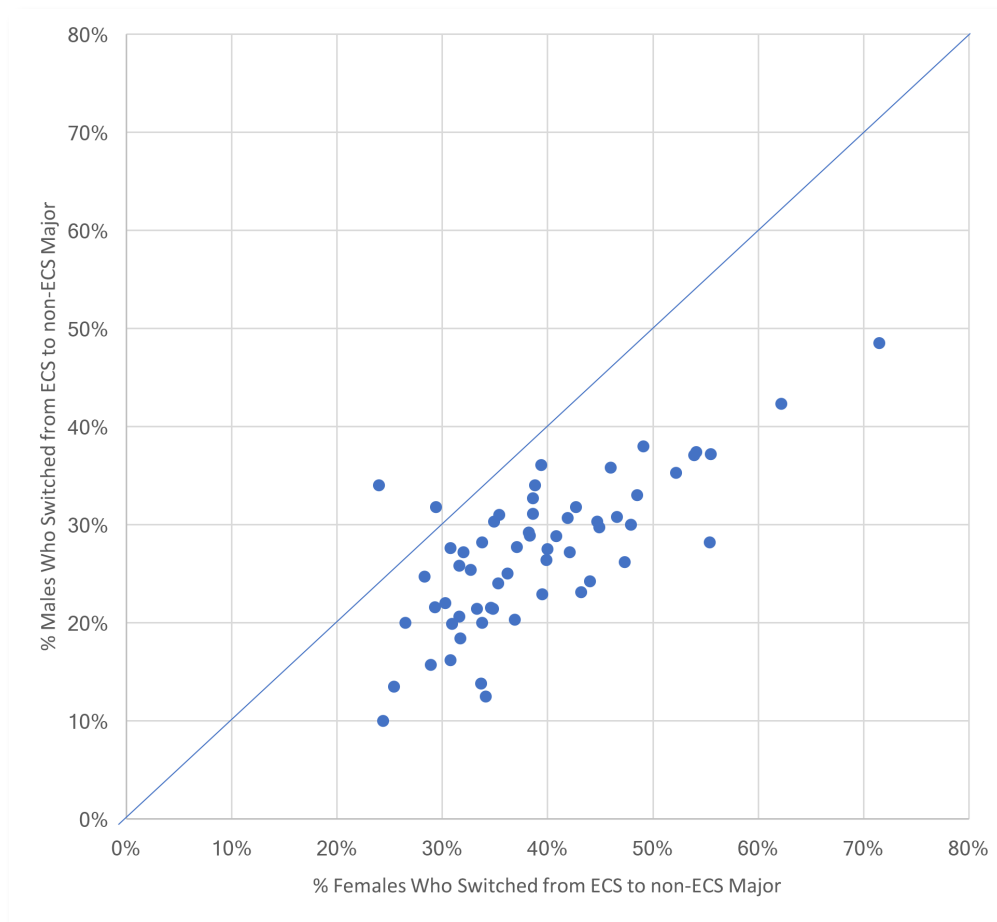


Note: Includes all public two-year and four-year enrollees who ever declared an ECS major between the 2002/03 school year and spring of the 2014/15 school year. For this analysis, major switching is assigned to the institution where a student first declared an ECS major, though a student may have switched majors after transferring to another institution.

Source: Texas Higher Education Coordinating Board CBM001 reports, 2002/03 to 2015/16.

Figure 10. Comparison of the Percentage of Male and Female Students Who Switched from an ECS Major to a Non-ECS Major, by Two-Year Institution, 2002/03 to 2011/12 FTIC Cohorts

Each Point Represents a Two-Year Community College



Note: Includes all public two-year and four-year enrollees who ever declared an ECS major between the 2002/03 school year and spring of the 2014/15 school year. For this analysis, major switching is assigned to the institution where a student first declared an ECS major, though a student may have switched majors after transferring to another institution.
Source: Texas Higher Education Coordinating Board CBM001 reports, 2002/03 to 2015/16.

For students who declared an ECS major in a four-year university between 2002/03 and 2011/12, an average of 46 percent of women and 37 percent of men switched to a non-ECS major by 2015. These major switching rates are higher than those seen by students in these FTIC cohorts who declared an ECS major at a two-year community college, where an average of 40 percent of women and 27 percent of men switched to a non-ECS major by 2015. Seven community colleges and six four-year universities saw over half of female ECS students switch out of ECS at some point while pursuing their degrees, while only one four-year institution saw such rates among male ECS students.

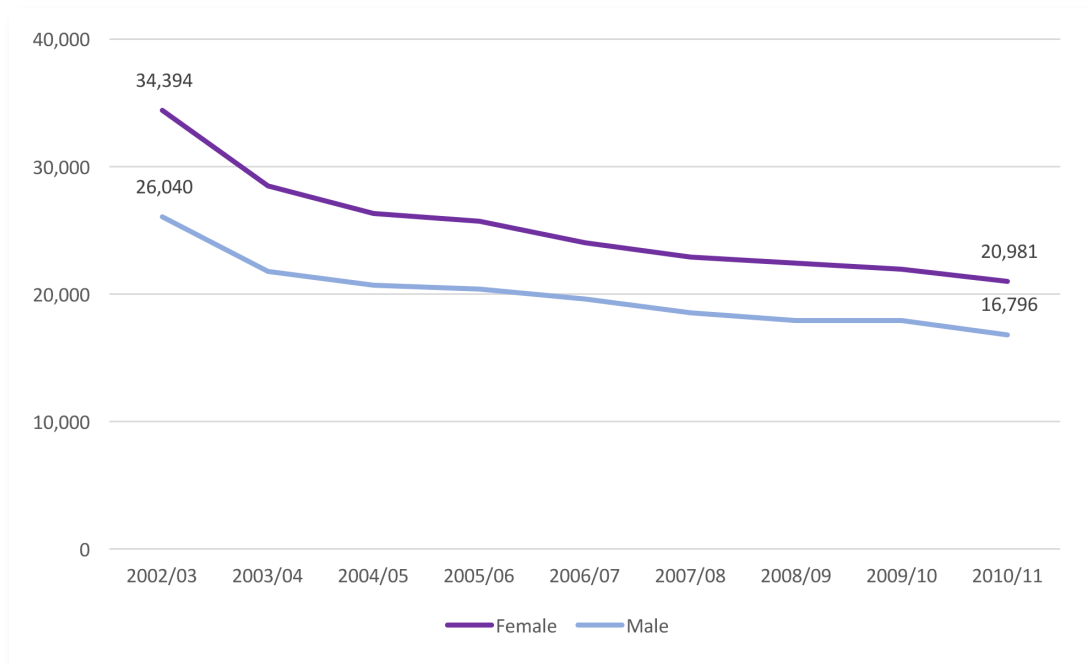
According to data from the National Student Clearinghouse Research Center, 48 percent of women and 44 percent of men awarded an associate’s degree eventually receive a bachelor’s degree.¹⁶

¹⁶ National Student Clearinghouse Research Center. (2016). *Certificate and Associate Degree Pathways* –

FEW TRANSFER STUDENTS DECLARE AN ECS MAJOR, BUT MANY WHO DO ARE EARNING ECS BACCALAUREATE DEGREES

Certainly, there are improvements to be made to increase the graduation rates of transfer students, but this represents thousands of baccalaureate degree earners each year. In Texas alone, there are tens of thousands of students who are transferring from public two-year community colleges to four-year universities with the intention of earning a bachelor's degree (Figure 11). More women than men are transferring, and this has been a consistent trend.

Figure 11. Number of Transfer Students from 2-Year to 4-Year Institutions, all Majors, by Gender, 2002/03 to 2010/11 FTIC Cohorts



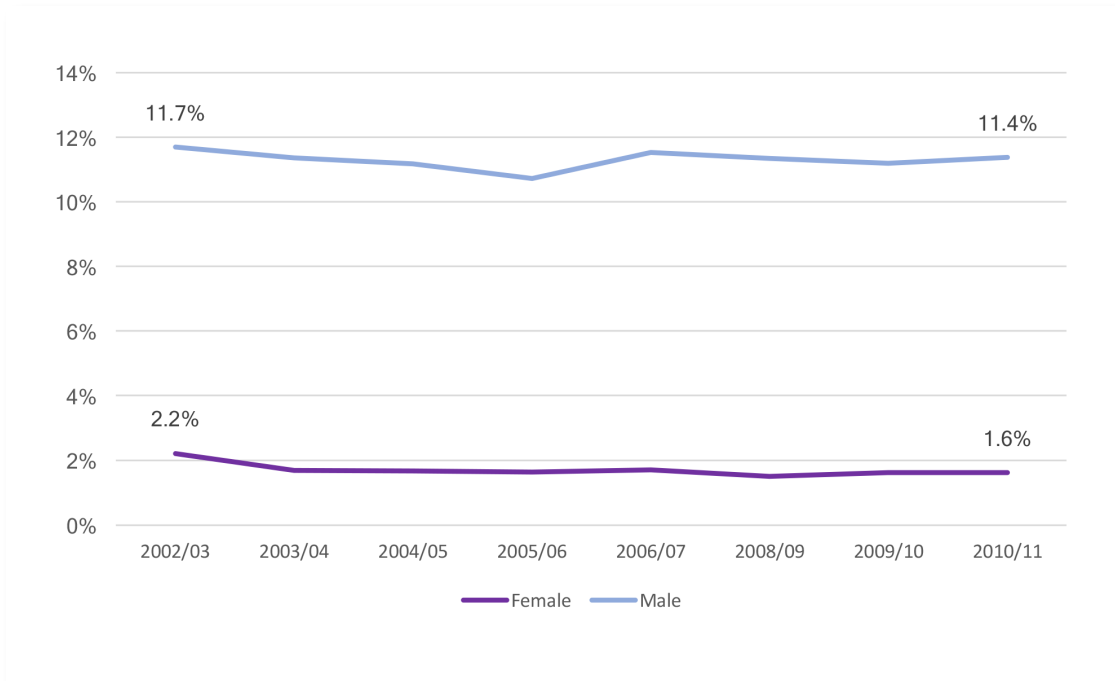
Note: Includes all public two-year enrollees who transferred from a two-year to a four-year public or private university. Students are included if they transferred in a subsequent semester (does not need to be sequential).

Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

State-Level Data Table.

One of the biggest issues affecting our ability to diversify the ECS professions is the low number of students who choose to major in ECS at transfer – particularly among women. In Texas, less than 2 percent of female transfer students selected an ECS major, compared to over 11 percent of men (Figure 12). This gap in ECS major declaration between male and female transfer students exists across all cohorts in the study. For the 2010/11 FTIC cohort, which included over 20,000 female transfers, this represents fewer than 500 female students in ECS compared to over 1,500 male transfer students from this same cohort. In other words, there were three times more men than women who transferred and selected an ECS major, despite having 20 percent fewer male transfers compared to female transfers from the 2010/11 FTIC cohort.

Figure 12. Percentage of Transfer Students Who Declared an ECS Major, by Gender, 2002/03 to 2010/11 FTIC Cohorts



Note: Includes all public two-year enrollees who transferred from a two-year to a four-year public university. Data for 2007/08 FTIC cohort was significantly affected by data suppression issues, so the 2007/08 FTIC cohort is not included in the graph.

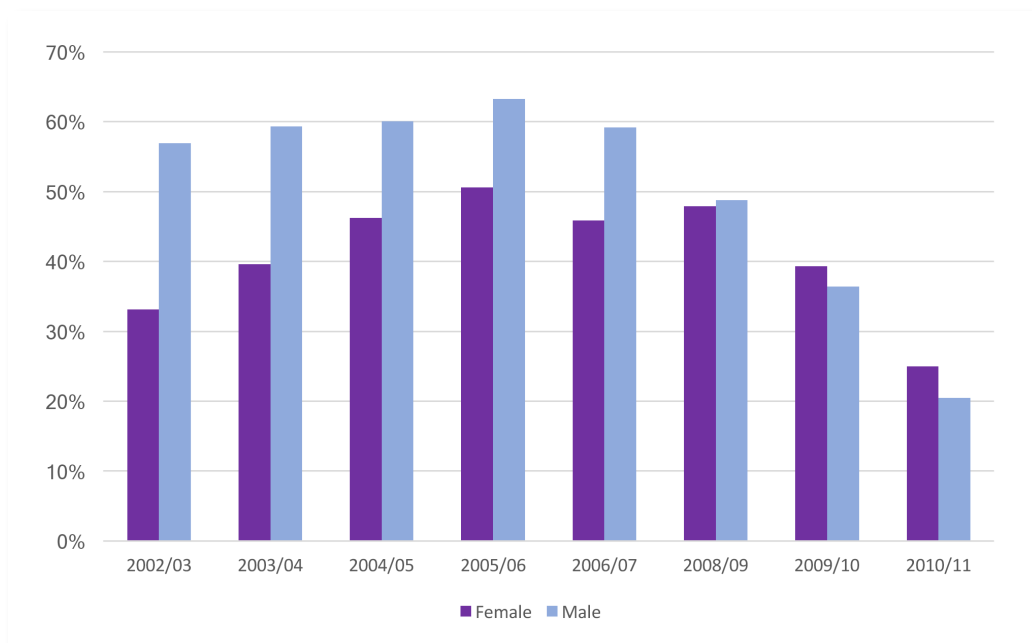
Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

Women Who Transfer to a Four-Year University and Declare an ECS Major Are Seeing Higher ECS Baccalaureate Degree Completion Rates than Men

Among transfer students who declared an ECS major, male and female ECS baccalaureate completion rates increased across the 2002/03 through 2005/06 FTIC cohorts (Figure 13). Though completion rates decreased for later cohorts, the study's Fall 2015 cutoff may not have provided enough time for later cohorts to complete their degrees. What can be noted is that female transfers in ECS saw higher ECS degree completion rates than male transfers in the 2009/10 and 2010/11 FTIC cohorts compared to prior years. What is unclear is whether this is due to women requiring less time than men to complete their degrees, or whether women's completion rates are going up at a faster rate than men's.

Completion rates among transfer students exceeded 60 percent for men and 50 percent for women from the 2005/06 FTIC cohort. This cohort had ten years to complete their degrees before the Fall 2015 cutoff utilized in this study. Subsequent FTIC cohorts may exceed these figures with time.

Figure 13. Percentage of Transfer Students Who Declared an ECS Major and Graduated with an ECS Baccalaureate Degree by 2015, by Gender and FTIC Cohort



Note: Includes all public two-year enrollees who transferred from a two-year to a four-year public university and earned a baccalaureate degree in ECS. Data for 2007/08 FTIC cohort was significantly affected by data suppression issues, so the 2007/08 FTIC cohort is not included in the graph.

Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

Despite the increase in female transfer students' ECS degree completion rates, there were actually fewer ECS baccalaureate degree earners for each subsequent FTIC cohort (Table 2). Much of this is attributable to the decrease in male transfer graduates, which is illustrated in the growing percentage of females among the total ECS transfer graduates. However, male transfer graduates consistently outnumber female transfer graduates for every cohort year included in this study. On average, there were fewer than 200 female transfer graduates in ECS in each FTIC cohort, while earlier FTIC cohorts saw over 1,000 male

Table 2. Number of Transfer Students Who Earned an ECS Baccalaureate Degree by 2015, by Gender and FTIC Cohort

FTIC Cohort	Female	Male	% Female of Total ECS Transfer Graduates
2002/03	253	1,733	12.7%
2003/04	191	1,466	11.5%
2004/05	203	1,388	12.8%
2005/06	214	1,382	13.4%
2006/07	187	1,338	12.3%
2007/08	195	1,241	13.6%
2008/09	161	992	14.0%
2009/10	140	731	16.1%
2010/11	85	391	17.9%

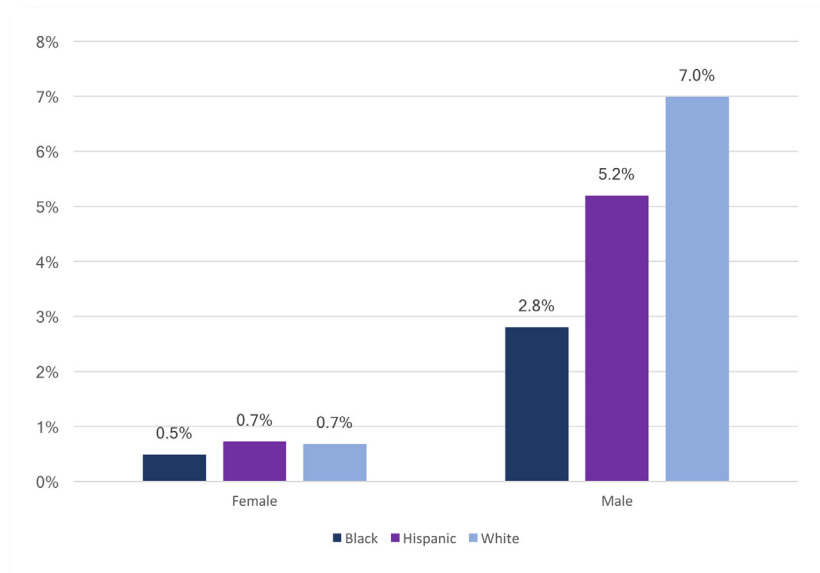
Note: Includes public two-year enrollees who transferred from a two-year to a four-year public university.

Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

Larger Racial/Ethnic Gaps in ECS Baccalaureate Degree Completion Are Seen among Men than Women

The percentage of female transfer graduates in ECS was relatively consistent across all racial and ethnic groups (Figure 14). Less than 1 percent of all Black, Hispanic, and White female transfers across all FTIC cohorts earned an ECS degree by Fall 2015.

Figure 14. Percentage of Transfer Students (All Majors) Who Earned an ECS Baccalaureate Degree by 2015 from the 2002/03 to 2011/12 FTIC Cohorts, by Gender and Race/Ethnicity



Note: Includes public two-year enrollees who transferred from a two-year to a four-year public university. Asian students are not shown due to issues with data suppression.

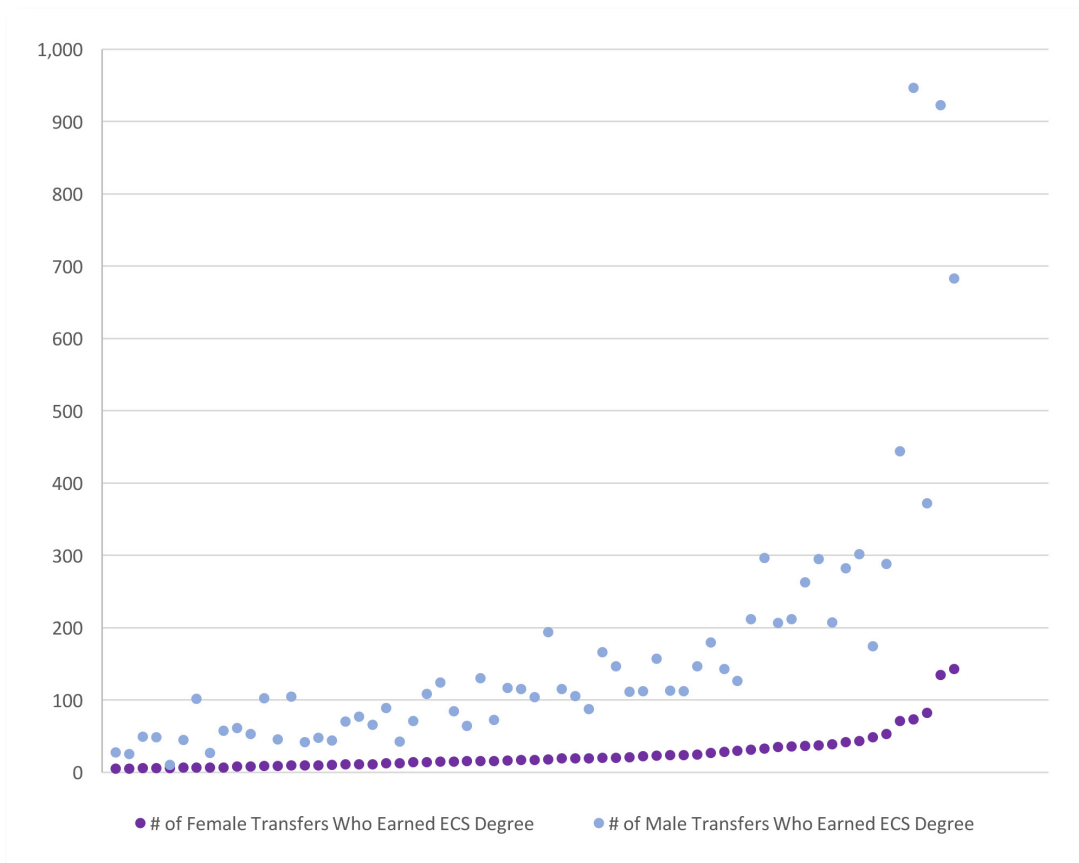
Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

Among male transfer students, approximately 7 percent of White students who transferred to a public four-year university from a community college earned an ECS baccalaureate degree. This is more than double the rate of ECS degree attainment seen for Black male transfer students and about 2 percent higher than Hispanic male transfer students. For male transfer students who earned an ECS baccalaureate degree, approximately 70 percent were White, 25 percent were Hispanic, and only 5 percent were Black. For female transfer students, 55 percent were White, 36 percent were Hispanic, and less than 10 percent were Black. Asian transfer student ECS degree earners were too low to be included in this analysis.

Across All Two-Year Community Colleges, More Men than Women Transfer and Complete ECS Baccalaureate Degrees

Figure 15 shows the number of male and female students who earned an ECS bachelor's degree by Fall 2015 and had transferred from one of 63 two-year colleges. Given the low number of women who choose to major in ECS, it is not surprising to see low female counts. What is notable are the institutions that are seeing hundreds of male students earning ECS baccalaureate degrees from the 2002/03 through 2011/12 FTIC cohorts: over 60 percent of the 63 two-year colleges included in this analysis had more than 100 male transfer graduates in ECS by Fall 2015. This compares to only two institutions that had more than 100 female transfer graduates in ECS.

Figure 15. Total Number of Transfer Students Who Earned an ECS Baccalaureate Degree by 2015 from the 2002/03 to 2011/12 FTIC Cohorts, by Gender and Sending Two-Year College



Note: Includes public two-year enrollees who transferred from a two-year to a four-year public university. Community colleges with fewer than five female or male ECS baccalaureate degree earners are not shown.

Source: Texas Higher Education Coordinating Board CBM001 and CBM009 reports, 2002/03 to 2015/16.

CONCLUSION

This study was initially conducted to find out how successful women in Texas were who transfer from a community college to a four-year university to complete their ECS baccalaureate degrees. We wanted to know if success varied by race, part-time versus full-time status, ECS discipline, academic preparation, and sending and receiving institutions so that we could understand what factors help or hinder women's success. We soon discovered that this was an unrealistic endeavor, because there are not enough women transferring from a two-year to four-year college in ECS to gain anything useful from the data disaggregation. In fact, we couldn't even report it, because the Texas Education Research Center would not release data when headcounts fell below five students. Needless to say, this itself was a surprising study finding – that in the second-most-populated state in the country, with about half of the population Hispanic or Black, there are so few women transferring and graduating in ECS that only high-level trend analyses can be reported.

But the high-level analysis was eye-opening. By starting with a look across all two-year and four-year institutions, we confirmed that women are less likely than men to declare an ECS major, but we discovered that their rates of ECS major declaration are decreasing over time. Also surprising was the discovery that Black and Hispanic students, regardless of gender, are increasingly less likely to choose to major in ECS.

Low rates of ECS major declarations among women and underrepresented minorities is a major concern, but of equal concern are the large numbers of students switching out of ECS at both two-year and four-year colleges. Of particular concern are the large gaps identified at individual institutions between the percentage of men and women switching out of ECS into a non-ECS major. Many institutions are seeing over half of women switching out of ECS, and most are seeing 10-20 percent more women switching than men.

As we explored the success of transfer students in ECS, the low numbers of women and underrepresented minorities transferring and completing ECS baccalaureate degrees was an interesting, if disheartening, discovery. Of the over 35,000 students who started college in 2010/11 and transferred from a two-year community college to a four-year university, fewer than 500 were women who chose an ECS major. As of the Fall 2015 data cutoff, only 25 percent had graduated with an ECS bachelor's degree – but given that half of women who started college in 2005/06 had earned an ECS bachelor's degree after transfer by Fall 2015, it may just take more time for community college transfer students to complete their degrees.

From the 10 years of FTIC cohorts included in this study, fewer than 1,300 women transferred and graduated with an ECS baccalaureate degree. Of these, less than 10 percent were Black women, and 35 percent were Hispanic. For men, among the almost 9,000 ECS graduates who had transferred from a community college from the 10 FTIC cohorts in the study, only 5 percent were Black, and 25 percent were Hispanic.

As more attention is paid to increasing the diversity of ECS fields, more research is needed to understand what helps and hinders students who choose to pursue an ECS degree starting at a community college. As this research into the success of students on this pathway in Texas shows, there is great potential to address the need for more ECS graduates while improving both the gender and racial diversity of the ECS professions if we can retain more community college students in ECS and support them through

transfer. National data show that over 65 percent of students who successfully transfer in engineering are graduating with engineering baccalaureate degrees. Our investigation into the success of ECS transfer students in Texas found very similar success rates, but getting students to that transfer point is the challenge.

It can be done, as many of the two-year community colleges in this study are sending hundreds of transfer students on to successfully earn their ECS baccalaureate degrees – though the gender gaps are staggering. More research is needed to determine what supports are necessary to increase the number of students staying in ECS majors at a community college and transferring to a four-year university – particularly among women and underrepresented minorities.

The community college pathway is an important entryway into a four-year ECS degree program. More attention to supporting students interested in transferring – before, during, and after transfer – has the potential to make a huge difference in our diversity efforts. The findings from this study can be used as a basis for further analysis into the programs, services, and additional supports that help students on the community college pathway toward an ECS baccalaureate degree.

RECOMMENDATIONS

Though the findings from this study indicate that low numbers of women and underrepresented minorities in Texas are transferring from two-year to four-year institutions and graduating with ECS baccalaureate degrees, the takeaway is really one of possibilities. With additional supports and encouragement for students who choose to major in ECS and start at a two-year college, the potential to increase diversity in ECS fields is significant because of the relatively high rates of success that transfer students are seeing after transfer. With this in mind, the following recommendations are offered:

Disaggregate and Analyze Data on Transfer Student Success in ECS

Many institutions and government entities are concerned about increasing diversity in STEM, focusing on improving the ease of transfer from two-year to four-year colleges and supporting STEM students at various stages along the pathway. The graduation rates of transfer students are gaining attention in higher education, as many institutions have noted that the traditional methods of reporting graduation rates have excluded the success of transfer students. However, disaggregated data by gender, race, and major concentration to measure enrollments, persistence, and graduation rates at a more granular level are not easy to find. Encouraging institutions and government entities to look at this level of data will help shed light on specific subgroups in STEM who may be struggling along the transfer pathway toward an ECS degree. Unless we can identify where the problems are occurring, we will have difficulty addressing them.

Find Out What Community College Students Need to Be Successful in ECS

All students pursuing an ECS baccalaureate degree are not alike. Though there are many programs and services in place to support university students in ECS, we need to understand what specific challenges and obstacles community college students are experiencing and develop programs and services to meet their needs. Some possible questions to ask include:

- How transferrable are courses taken at a community college for students majoring in ECS, and is this communicated to students?
- Are there financial aid resources available to assist ECS transfer students?
- Do ECS students in community colleges have access to academic counselors knowledgeable about the requirements of ECS programs among local universities?
- What internship opportunities are available to ECS community college students?
- Do community college students in ECS have access to people working in their field to serve as role models and mentors? To university peers?

Set Goals for ECS Transfer Student Enrollment, Success, and Completion

Much of the resources allocated to supporting STEM students in higher education have been toward supporting university students. We measure what we value, and we invest in what is measured so we can meet the goals that have been set. If diversity in ECS is important, and we know that community colleges are enrolling high numbers of underrepresented students into ECS majors with intentions to transfer and complete an ECS baccalaureate degree, then setting goals, allocating resources to programs and services to help us meet those goals, and continuously measuring progress is the only way we will see the impact of our investment into ECS transfer success. Universities cannot do this alone: this effort requires a network of support from government, community colleges, universities, industry, professional associations, and other nonprofits interested in diversifying engineering and technical professions.

NEXT STEPS

The Society of Women Engineers conducted this study to gain a better understanding of the success of women on the ECS transfer pathway. Now that the baseline has been set, SWE intends to conduct further study to understand the specific challenges that women on this pathway face. What we learn will inform the efforts of SWE and other diversity-serving organizations toward better supporting women and other underrepresented groups towards ECS baccalaureate degree completion. The next phase of research planned will include a qualitative study of women on the community college pathway, as well as a pilot program aimed at developing inclusive programming to introduce community college women to the collegiate, professional, and corporate networks that SWE offers. It is our belief that the support networks, professional development opportunities, and career resources that organizations like SWE provide can make a difference in women's decisions to persist, graduate, and enter the engineering and computer science workforce.

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APPENDIX A: ENGINEERING AND COMPUTER SCIENCE DISCIPLINES CATEGORIZED AS ECS

List of Included Engineering and Computer Science Disciplines

CIP Family	CIP Code	CIP Title
11	11	COMPUTER AND INFORMATION SCIENCES AND SUPPORT SERVICES.
11	11.0101	Computer and Information Sciences, General.
11	11.0103	Information Technology.
11	11.0301	Data Processing and Data Processing Technology/Technician.
11	11.0401	Information Science/Studies.
11	11.0501	Computer Systems Analysis/Analyst.
11	11.0701	Computer Science.
11	11.0803	Computer Graphics.
11	11.1002	System, Networking, and LAN/WAN Management/Manager.
11	11.1003	Computer and Information Systems Security/Information Assurance.
14	14	ENGINEERING.
14	14.0101	Engineering, General.
14	14.0201	Aerospace, Aeronautical and Astronautical/Space Engineering.
14	14.0301	Agricultural Engineering.
14	14.0401	Architectural Engineering.
14	14.0501	Bioengineering and Biomedical Engineering.
14	14.0701	Chemical Engineering.
14	14.0801	Civil Engineering, General.
14	14.0901	Computer Engineering, General.
14	14.0903	Computer Software Engineering.
14	14.1001	Electrical and Electronics Engineering

APPENDIX A: ENGINEERING AND COMPUTER SCIENCE DISCIPLINES CATEGORIZED AS ECS

CIP Family	CIP Code	CIP Title
14	14.1004	Telecommunications Engineering.
14	14.1201	Engineering Physics/Applied Physics.
14	14.1401	Environmental/Environmental Health Engineering.
14	14.1801	Materials Engineering.
14	14.1901	Mechanical Engineering.
14	14.2001	Metallurgical Engineering.
14	14.2201	Naval Architecture and Marine Engineering.
14	14.2301	Nuclear Engineering.
14	14.2401	Ocean Engineering.
14	14.2501	Petroleum Engineering.
14	14.2701	Systems Engineering.
14	14.3101	Materials Science.
14	14.3301	Construction Engineering.
14	14.3501	Industrial Engineering.
14	14.3601	Manufacturing Engineering.
14	14.3901	Geological/Geophysical Engineering.
15	15	ENGINEERING TECHNOLOGIES AND ENGINEERING-RELATED FIELDS.
15	15	Engineering Technology, General.
15	15	Engineering Technology, General.
15	15.0101	Architectural Engineering Technology/Technician.
15	15.0201	Civil Engineering Technology/Technician.

APPENDIX A: ENGINEERING AND COMPUTER SCIENCE DISCIPLINES CATEGORIZED AS ECS

CIP Family	CIP Code	CIP Title
15	15.0303	Electrical, Electronic, and Communications Engineering Technology/Technician.
15	15.0404	Instrumentation Technology/Technician.
15	15.0612	Industrial Technology/Technician.
15	15.0613	Manufacturing Engineering Technology/Technician.
15	15.0701	Occupational Safety and Health Technology/Technician.
15	15.0703	Industrial Safety Technology/Technician.
15	15.0805	Mechanical Engineering/Mechanical Technology/Technician.
15	15.1001	Construction Engineering Technology/Technician.
15	15.1102	Surveying Technology/Surveying.
15	15.1201	Computer Engineering Technology/Technician.
15	15.1301	Drafting and Design Technology/Technician, General.
30	30	MULTI/INTERDISCIPLINARY STUDIES.
30	30.0801	Mathematics and Computer Science.

ABOUT THE SOCIETY OF WOMEN ENGINEERS

The Society of Women Engineers (SWE), founded in 1950, is the world's largest advocate and catalyst for change for women in engineering and technology. SWE is a not-for-profit educational and service organization that empowers women to succeed and advance in the field of engineering and to be recognized for their life-changing contributions as engineers and leaders. SWE is the driving force that establishes engineering as a highly desirable career for women through an exciting array of training and development programs, networking opportunities, scholarships, and outreach and advocacy activities. With a global presence and over 37,000 members, SWE offers unique opportunities to network, provides professional development, shapes public policy, and provides recognition for the life-changing contributions and achievements of women engineers. As a champion of diversity, SWE empowers women to succeed and advance in their personal and professional lives.