



Research shows *FIRST*[®] drives STEM engagement and outcomes

FIRST[®] is a mission-driven global robotics community that prepares young people for the future and inspires today's kids to build tomorrow's leaders.

Children can join any of our three programs based on age or grade level. Ages may vary by region.



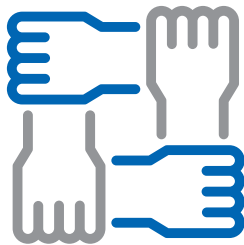
Research from a multi-year longitudinal study shows *FIRST* is advancing its mission to increase the number of students interested in STEM – and that interest is influencing their educational and career choices.

FIRST students are prepared for greater success in the classroom and workforce.

At *FIRST*, we understand that interest, rather than academic proficiency, is a greater predictor of children pursuing studies and careers in STEM fields. Our evidence-based programs use strategies known to increase student interest and engagement in science, technology, engineering, and math (STEM), including:



HANDS-ON LEARNING



WORKING AS A TEAM ON REAL-LIFE PROBLEMS



EXPOSURE TO CAREERS AND ADULT MENTORS



EMPHASIS ON *FIRST* CORE VALUES



CULMINATING CELEBRATION WHERE STUDENTS CAN SHOWCASE WHAT THEY CREATED AND LEARNED

OUR PARTNERSHIP WITH BRANDEIS UNIVERSITY

FIRST is partnering with Brandeis University to conduct a multi-year longitudinal study measuring STEM-related impacts.

The study included 822 *FIRST* students and 451 comparison group students. The comparison group included students who did not participate in *FIRST* programs, but were enrolled in science and math classes at the same schools. All students received a baseline survey and follow-up surveys each year.

OVERALL, 74% OF STUDENTS REMAINED IN THE STUDY AT YEAR NINE.



Research Highlights

FIRST prepares students for a STEM future



Gains in Workforce Skills

FIRST participants show significant gains in workforce skills such as teamwork, communication, and problem-solving.

“FIRST has given me life skills and tools to work well with others and be a team player and always do my personal best with *Gracious Professionalism*®. These are skills I will use in my daily life and beyond!”

FIRST Alumni

By their fourth year of college, FIRST alumni are more likely to be majoring in STEM fields than comparison group peers.



DECLARE A MAJOR IN STEM (SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH)

FIRST ALUMNI

81%

COMPARISON GROUP

64%

DECLARE A MAJOR IN ENGINEERING OR COMPUTER SCIENCE

FIRST ALUMNI

59%

COMPARISON GROUP

24%

Women in FIRST

Young women in FIRST have significant gains in all STEM areas including STEM interest, career interest, activity, knowledge, and identity compared to young women in the comparison group.

DECLARE A MAJOR IN ENGINEERING OR COMPUTER SCIENCE

FEMALE FIRST ALUMNI

48%

FEMALE COMPARISON GROUP

16%

MORE LIKELY TO TAKE COURSES IN ENGINEERING OR COMPUTER SCIENCE

3.5x

Computer Science

2.5x

Engineering



"x" = times as likely

Benefits of FIRST

FIRST students are two times more likely to show an increase in STEM-related attitudes and interests than comparison group students. Positive impacts are evident for all FIRST students regardless of race, gender, income, or community type.



FIRST STUDENTS ARE SIGNIFICANTLY MORE LIKELY TO SHOW GAINS IN STEM OUTCOMES THAN COMPARISON STUDENTS

2x

STEM Interest
STEM Career Interest
STEM Knowledge

STEM Activity
STEM Identity

Detailed information about the study can be found at www.firstinspires.org/impact

All differences statistically significant, $p < .05$ Sources: FIRST Longitudinal Study: 2022 Survey Results (108-Month Follow-Up). Brandeis University. February, 2023.

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Research shows *FIRST*[®] has a lasting impact on girls and young women

Women are critical to the advancement of STEM (Science, Technology, Engineering, and Math) – but a significant gender gap remains within STEM careers. At *FIRST*[®], we are actively developing ways to address barriers to access and participation, particularly in managing and allocating resources, programs, and educational opportunities fairly to all genders. We are committed to creating a diverse, inclusive, and equitable community for all participants.

Girls in *FIRST* see amazing impacts. All *FIRST* participants are significantly more likely to have stronger STEM outcomes compared to their classmates, as evidenced by the *FIRST* Longitudinal Study. However, girls in *FIRST* report the largest differences in STEM outcomes over time when compared to their female peers, and higher than boys.

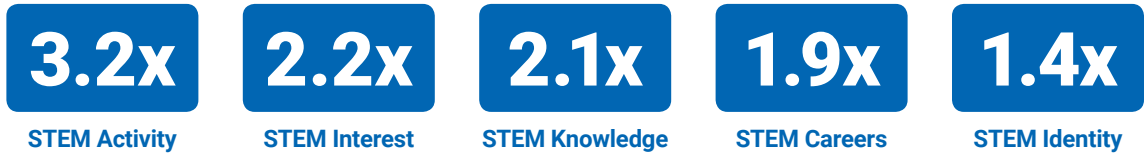


STEM Outcomes

Female *FIRST* participants are 2.2 times more likely to have significantly stronger STEM interest than comparison group peers, and:



MORE LIKELY TO HAVE SIGNIFICANTLY STRONGER OUTCOMES IN STEM ATTITUDES, KNOWLEDGE, AND INTERESTS COMPARED TO THEIR PEERS



"x" = times as likely

STEM Pathways

Female *FIRST* alumni are more likely to pursue STEM pathways through 4 years of college compared to their peers in the comparison group:



MORE LIKELY TO TAKE ENGINEERING AND COMPUTER SCIENCE COURSES



MORE LIKELY TO HAVE DECLARED A MAJOR IN ENGINEERING AND COMPUTER SCIENCE



% OF FEMALE *FIRST* ALUMNI WHO DECLARE A STEM MAJOR COMPARED TO THEIR PEERS

FEMALE *FIRST* ALUMNI

69%

FEMALE COMPARISON GROUP

49%

MORE LIKELY TO DECLARE A MAJOR IN ENGINEERING OR COMPUTER SCIENCE THAN THEIR PEERS

FEMALE *FIRST* ALUMNI

51%

FEMALE COMPARISON GROUP

16%

Additional Highlights

Gains in Workforce Skills

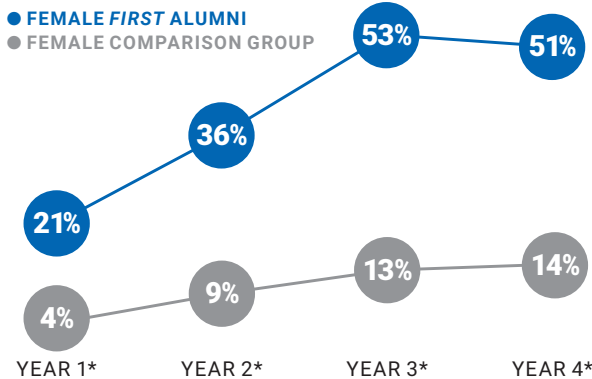
"FIRST has made such a large impact on my life that I don't know where or who I would be without it. I have been involved with FIRST for seven years, and the experiences that I have had have given me public speaking skills, confidence in my abilities, and life-long friendships. FIRST also has given me the opportunity to inspire others in STEAM fields."



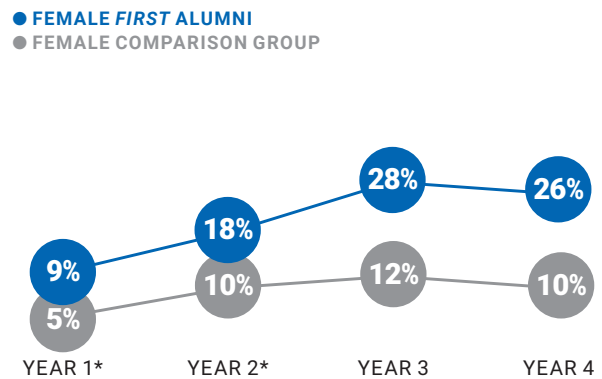
Declare STEM Majors

More female FIRST alumni declare majors in Engineering and Computer Science compared to young women in the comparison group.

% OF ENGINEERING MAJORS



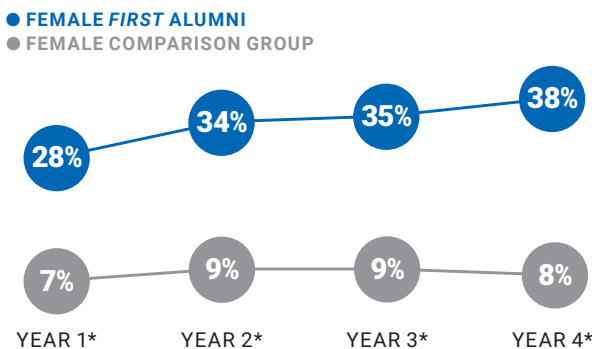
% OF COMPUTER SCIENCE MAJORS



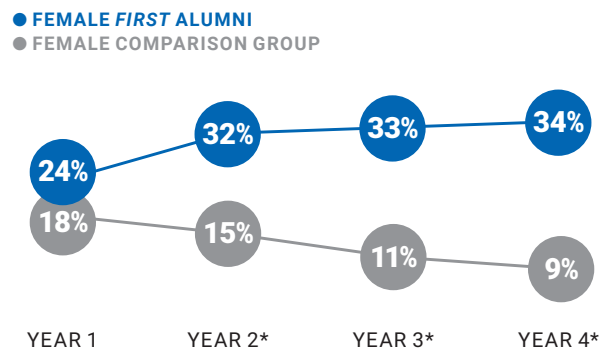
Take STEM Coursework

Female FIRST alumni are more likely to take coursework in Engineering or Computer Science each of the 4 years of college compared to their peers.

% OF ENGINEERING COURSEWORK



% OF COMPUTER SCIENCE COURSEWORK



FIRST LONGITUDINAL STUDY BACKGROUND

FIRST is partnering with Brandeis University to conduct a multi-year longitudinal study measuring STEM-related impacts. The study included 822 FIRST students and 451 comparison group students. The comparison group included students who did not participate in FIRST programs, but were enrolled in science and math classes at the same schools. All students received a baseline survey and follow-up surveys each year. There were 422 women in the study at year seven (194 FIRST participants and 228 comparison group).

OVERALL, 74% OF STUDENTS REMAINED IN THE STUDY AT YEAR SEVEN.

Detailed information about the study can be found at www.firstinspires.org/impact

FIRST Longitudinal Study: Findings at 84-Month Follow-Up, Brandeis University, March, 2021.

*Differences statistically significant, $p \leq .05$

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***FIRST*[®] Longitudinal Study:
2022 Survey Results (108-Month Follow-Up)**

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February 2023

FIRST® Longitudinal Study: Findings at 108-Month Follow-Upⁱ

*“FIRST helped me understand that **working together** is something natural and healthy for us humans to do, and has helped me to become a more social and outgoing person.” (FIRST female participant)*

*“I think participating in FIRST at such a young age **opened my mind to loving science and math**. Before I wasn't very inclined to gravitate towards it but now I think I do.” (FIRST male participant)*

KEY FINDINGS AT 108-MONTH FOLLOW-UP

- *FIRST*® participants continue to show positive impacts on STEM-related interests and attitudes nine years (108 months) after they entered the program. Impacts include higher interest in STEM, involvement in STEM-related activities, STEM identity, STEM knowledge, and interest in STEM careers when compared to a matched comparison group.
- Participants from all major population groups and community types show positive impacts, including both males and females, underrepresented racial/ethnic groups, youth from lower and higher income families, and from urban, rural, and suburban communities.
- Impacts on STEM attitudes and interests continue to be significantly greater for young women in *FIRST* than those for young men.
- *FIRST*'s impacts persist into college. Through the fourth years of college, *FIRST* alumni:
 - continue to show significantly greater scores on STEM-related attitudes than comparison students;
 - are significantly more likely to be interested in majoring in computer science and engineering;
 - are two to nearly three times more likely to take computer science and engineering courses in college; and
 - are significantly more likely to declare a major in computer science, engineering, or a STEM-related field than comparison students. By the end of their 4th year of college, 81% of *FIRST* alumni had declared a STEM major; compared to 64% of comparison group study participants.
- In their 4th year of college, female *FIRST* alumni continue to pursue STEM-related courses and majors at a high rate in college. Female *FIRST* alumni were 3 times more likely to major in engineering than their comparison group counterparts.
- Preliminary data on early career positions show *FIRST* alumni at significantly greater rates in engineering positions, with 61% of them working in a STEM field compared to 44% of the comparison group.

Impacts 108-Months After Program Entry

In this report, we summarize trends on the long-term impact of participating in *FIRST* (please see the Appendix for study details). The results are based on nine years of data, including survey data from

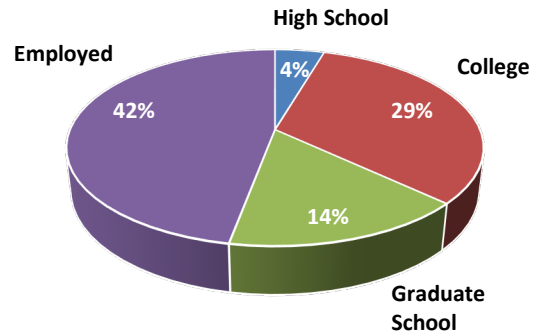
Data Collection through 108-Month Follow-Up

GROUP	Baseline	12-Month Follow-Up (Post-Program)	24-Month Follow-Up	36-Month Follow-Up	48-Month Follow-Up	60-Month Follow-Up	72-Month Follow-Up	84-Month Follow-Up	96-Month Follow-Up	108-Month Follow-Up
<i>FIRST</i> Participants	822	677	665	636	611	602	550	554	570	559
Comparison Group	451	259*	411	409	406	397	386	389	385	379
Total	1273	936	1076	1045	1017	999	936	943	955	938

*The initial group of comparison students did not complete a post-program survey but have participated in all subsequent follow-up surveys.

baseline and post-program surveys and seven rounds of annual follow-up surveys. As such, it reflects the impacts of participation in *FIRST* nine years after study participants entered the program. Of the 1,273 students who began the study, 938 students (74%) completed the 108-month follow-up survey, including 559 *FIRST* participants (68% of those at baseline) and 379 comparison students (84% of those at baseline). Of the *FIRST* participants responding to the follow-up survey, 96% were post high school and 5 (<1%) were still active in the program.ⁱⁱ

108-Month *FIRST* Survey Respondents

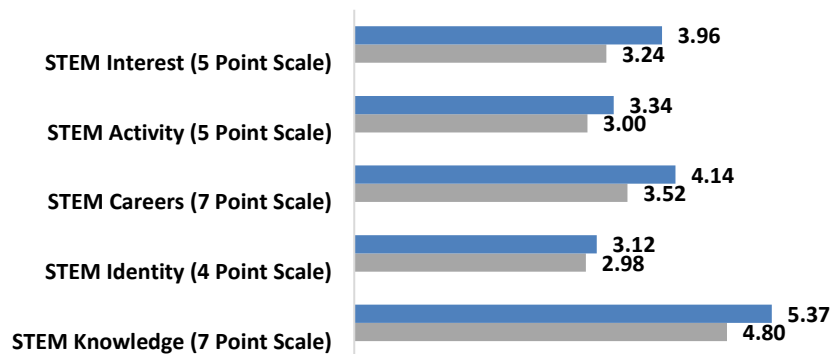


The findings from the 108-month follow-up surveys extend and underscore the positive impact findings from the prior (2015-2021) annual impact reports: ***FIRST* participants continue to show significantly greater average levels on STEM-related attitudes and interests than comparison students and are statistically significantly more likely to show higher levels in STEM-related education and employment outcomes than students in the comparison group.** These positive impacts hold true for participants who originally enrolled in any one of the three *FIRST* programs in the study (*FIRST* LEGO League Challenge, *FIRST* Tech Challenge, and *FIRST* Robotics Competition), across key demographic groups, and for those living in different types of communities (urban, rural, suburban).ⁱⁱⁱ Data on students in their first four years of college also point to positive, statistically significant long-term impacts. **Through their fourth year of college, *FIRST* alumni show stronger STEM-related attitudes and interests than comparison students; are more interested in majoring in key STEM-related fields (engineering, computer science, and robotics); are more likely to take engineering and computer science courses; and are more likely to have declared majors in engineering and computer science. By the fourth year of college, of the *FIRST* alumni who had declared a major, 81% were majoring in a STEM-related field.** In most cases, these college impacts apply to both male and female *FIRST* alumni. Major findings are as follows.

Impacts on STEM-Related Attitudes (All Participants)

At 108 months, *FIRST* participants continue to show positive, statistically significant impacts on all of the STEM-related attitude measures in the study, including interest in STEM, involvement in STEM-related activities, STEM identity, STEM knowledge, and interest in STEM careers. *FIRST* participants are approximately twice as likely to show higher levels on STEM-related measures nine years after entering the program as students in the comparison group.

STEM-Related Interests and Attitudes at 108 Months
(Averages in Scale Scores)



Note: All results are statistically significant at $p \leq .05$. All impacts showed a medium to large effect size.

- FIRST* participants continue to show significantly higher levels on all measures of STEM-related interest and attitudes than members of the comparison group.** In each case, the “effect size” (a measure of the magnitude of the impact being measured) was large enough to indicate a *practical* difference in attitudes and interests.^{iv} The STEM-related measures include:
 - *Interest in STEM,*
 - *Involvement in STEM-related activities* (e.g. reading or watching science programs)
 - *Interest in STEM careers* (such as scientist, engineer, STEM educator),
 - *STEM identity* (for example, “I see myself as a math, science, or technology person”), and
 - *STEM knowledge/understanding* (items include: “I want to learn more about science and technology,” “I have a good understanding of how engineers work to solve problems,” and “I can use math and science to make a difference in the world”).

After controlling for differences in baseline characteristics and baseline scale scores, *FIRST* participants are 2.2 times more likely than comparison students to be interested in STEM, from baseline to 108-month follow-up.^v

FIRST participants are also:

- 1.9 times more likely to report a stronger *STEM identity*;
 - 1.9 times more likely to score higher in *STEM knowledge/understanding of STEM*;
 - 1.5 times more likely to show higher involvement in *STEM activity*; and
 - 1.4 times more likely to show higher interest in *STEM careers*.
- The 108-month data also continue to show positive, statistically significant impacts on STEM-related outcomes for participants from all three FIRST programs in the study (FIRST LEGO League Challenge, FIRST Tech Challenge, FIRST Robotics Competition).*** Participants from each of the three *FIRST* programs (program type at entry into *FIRST*) show significantly higher scores on STEM-related measures than comparison students from the same age/grade span.

- **STEM-related impacts continue to be evident across all major population groups and among students from historically underrepresented communities (compared to similar students in the comparison group).** Each of the following groups – males and females, lower and higher income students (family incomes below and above \$50,000), White youth and historically underrepresented racial and ethnic groups in STEM (Black or African-American, Native American, Hawaiian/Pacific Islander, Multi-Racial, and Latinx), and urban, suburban, and rural youth – shows significantly greater levels in STEM related attitudes for *FIRST* participants over counterparts among comparison group students.

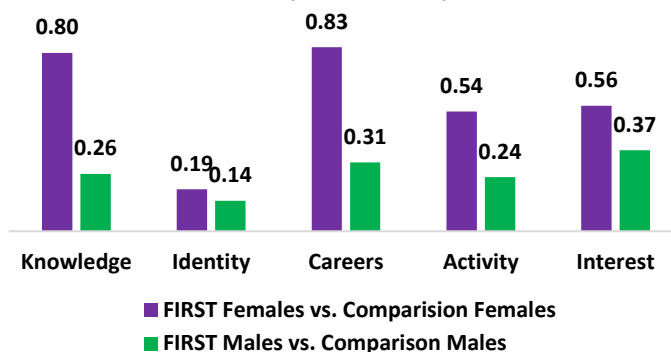
Positive and Significant Impacts for Underrepresented Communities

Outcomes	Girls and Young Women	Economically Disadvantaged	Underrepresented Racial/Ethnic Groups	Urban	Rural
STEM Interest	+	+	+	+	+
STEM Activity	+	+	+	+	+
STEM Careers	+	+	+	+	+
STEM Identity	+	+	+	+	+
STEM Knowledge	+	+	+	+	+

Note: + indicates a positive, significant impact at $p \leq .05$. Impacts are relative to comparable subgroups in the comparison population (for example, girls and young women among *FIRST* participants are compared to girls and young women in the comparison group). Economically Disadvantaged is defined as those whose family income is below \$50,000. Underrepresented Racial Groups include Black or African-American, Native American, Hawaiian/Pacific Islander, Multi-Racial, and Latinx. The number of youth who responded as non-gender-binary was too small for analysis.

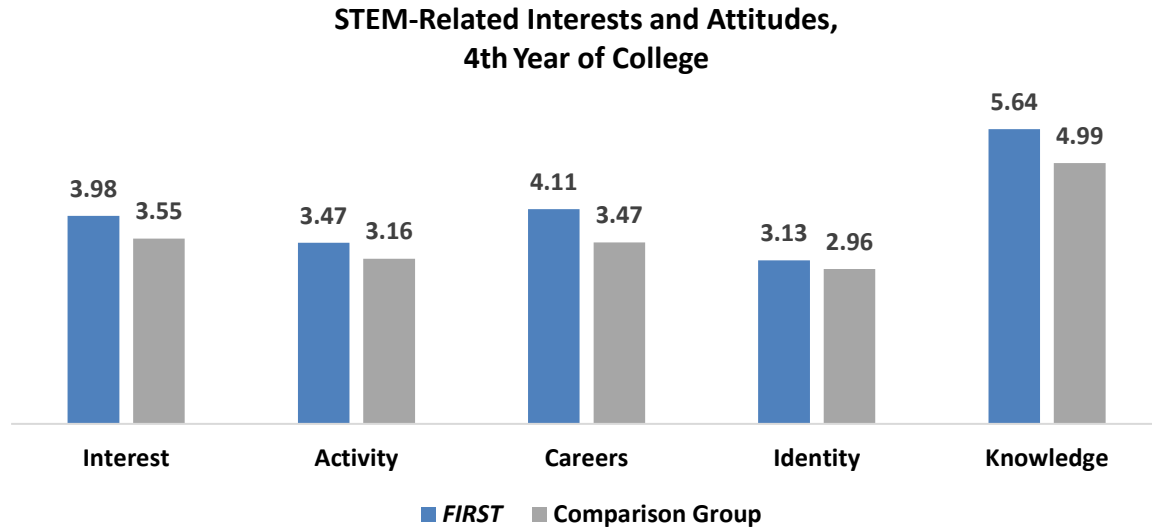
While the data show positive impacts for both male and female *FIRST* alumni, *FIRST* female participants continue to show significantly larger impacts than male participants on all of the STEM-related attitudinal measures. The chart to the right shows the differences in outcomes for young women in *FIRST* compared to young women in the comparison group, and for young men in *FIRST*, compared to young men in the comparison group. While all of the differences between *FIRST* participants and comparison students are statistically significant, the impacts for female participants in *FIRST* on each measure are also significantly greater than those for male participants, as evidenced by the higher purple bars in the graph to the right.

Differences in Scale Scores on STEM-Related Interests and Attitudes between *FIRST* and Comparison Group

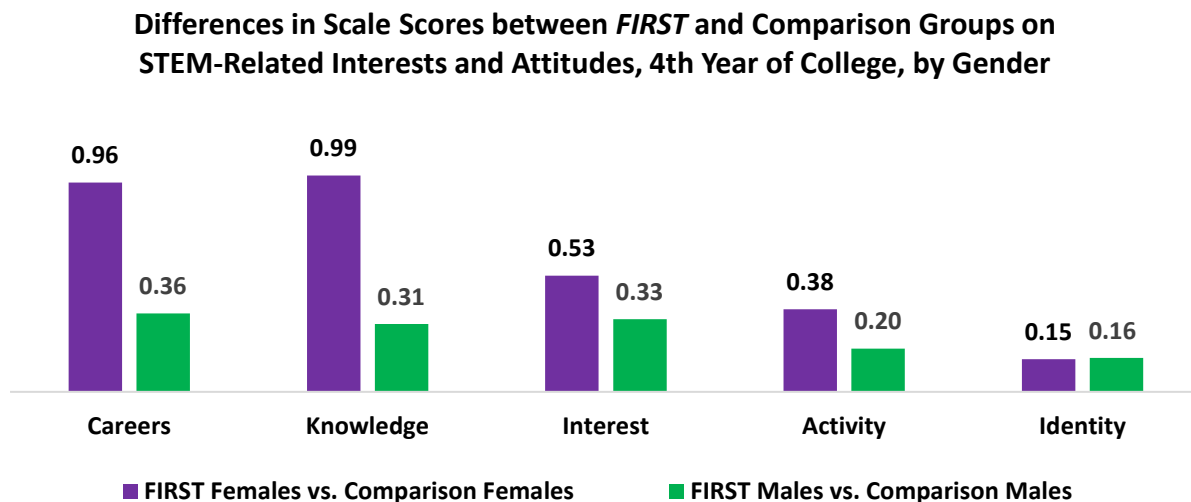


Note: Values on the chart represent the differences in outcomes (estimated scale scores) between *FIRST* participants and students of the same gender in the comparison groups (i.e., the difference in scores between males in *FIRST* and males in the comparison group and between females in *FIRST* and female comparison students). All differences are statistically significant at $p \leq .05$.

The impact of FIRST on STEM-related attitudes and interests persists into college. FIRST alumni continue to show consistent significantly higher scores than comparison students on measures of interest in STEM, STEM activity, interest in STEM careers, STEM identity, and STEM knowledge and understanding through the fourth year of college. Both male and female alumni show significant impacts; however, female FIRST alumni continue to show significantly higher levels than male alumni on all STEM measures.



FIRST participants consistently show significant higher levels on STEM outcomes than comparison students of the same gender. These differences are greatest for young women, especially for the careers and knowledge scales, when comparing FIRST participants with female comparison group members.



Note: Values on the chart represent the differences in outcomes (estimated scale scores) between FIRST alumni and students of the same gender in the comparison groups (i.e., the difference in scores between males in FIRST and males in the comparison group and between females in FIRST and female comparison students). All differences are statistically significant at $p \leq .05$.

Impacts on College Pathways through Four Years of College

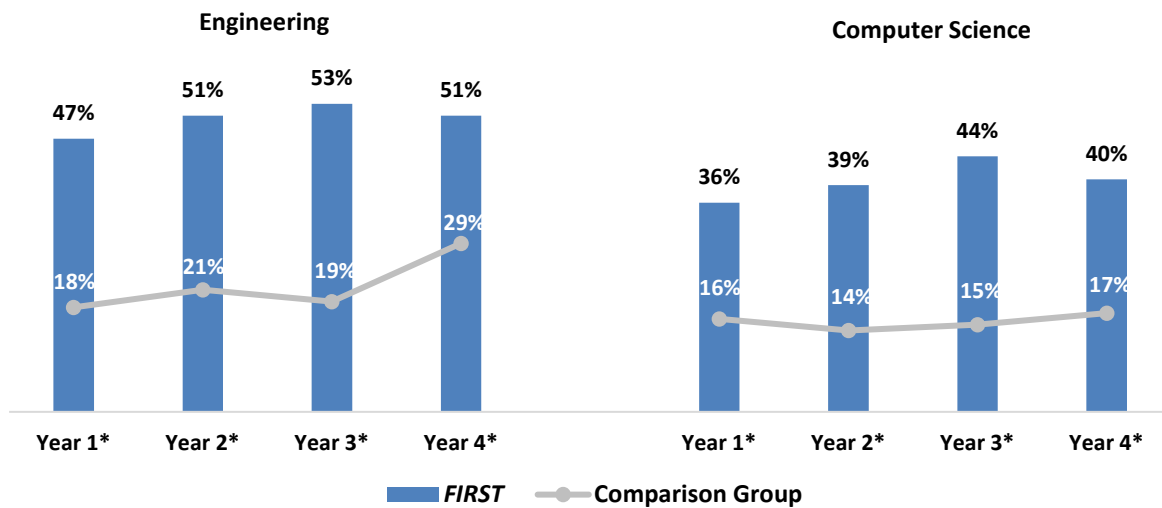
In addition to its impacts on STEM-related interests and attitudes, participation in *FIRST* has a significant impact on the education trajectories of *FIRST* alumni attending college.

# of Students by Year in College	N
4 years completed	466
3 years completed	668
2 years completed	801
1 year completed	933

Through their fourth year of college, *FIRST* alumni are significantly more interested in majoring in engineering and computer science than comparison students; are significantly more likely to take engineering and computer science courses; and are significantly more likely to have declared majors in engineering and computer science. By the fourth year of college, 81% of *FIRST* alumni were majoring in a STEM-related field compared to 64% of comparison students; 59% had declared a major in engineering or computer science versus just 24% for comparison students.

- FIRST* alumni report significantly stronger interest in majoring in engineering and computer science than comparison students through four years of college.** *FIRST* alumni were significantly more likely than comparison students to be “very interested” in majoring in engineering and computer science than comparison students.

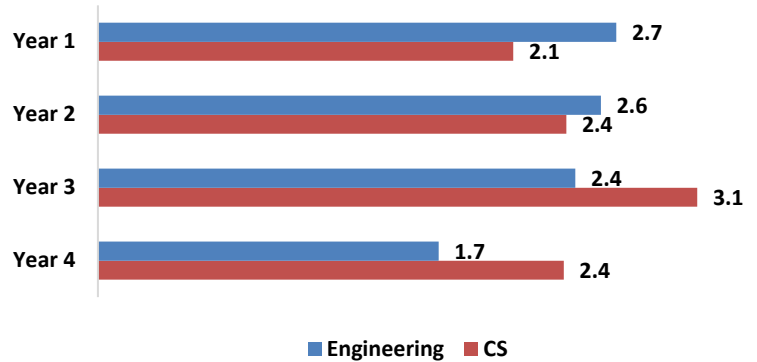
Interest in Engineering and Computer Science Majors, Years 1-4 in College
(Percent “Very Interested”)



Note: Based on a question asking students to rate their interest in majoring in each of the listed subjects. Values shown are percent of students who are “very interested” in the specified major (i.e., reporting 6, 7 or “already declared” on a scale from 1 “Not Interested at All” to 7 “Very Interested”). Asterisk (*) indicates statistically significant at $p \leq .05$. *FIRST* alumni also showed significantly stronger interest in majoring in robotics (not shown) in all four years.

- Except in Year 4 for engineering, **FIRST participants are at least twice as likely to be interested in either engineering or computer science**
- Unlike in Years 1 and 2 in college, when the interest in Engineering was greatest for *FIRST* participants, **in Year 3 interest for computer science was greatest** and it remained greater than interest for engineering in Year 4.

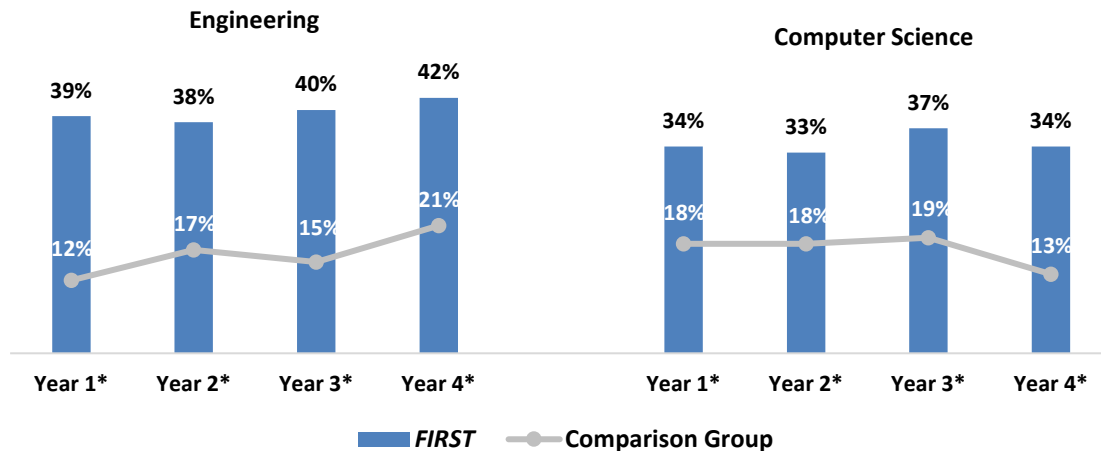
FIRST Participants Likelihood* of Interest in Engineering & Computer Science Majors



**Note: Logistic regressions estimates on the interest in majoring scale controlling for Gender, Race, Honors Courses, Family Income, and Parental Support for STEM*

- **FIRST alumni are consistently significantly more likely to take engineering or computer science courses during their four years in college than comparison students.** In their first year of college, 39% of *FIRST* alumni were taking an engineering course, compared to 12% in the comparison group, and 34% a computer science course, compared to 18% of comparison students. In their second college year, 38% of *FIRST* alumni were taking engineering and 33% computer sciences courses, compared to 17% and 18% of comparison students. By the third year of college, 40% of *FIRST* alumni reported taking at least one engineering class and 37% reported taking at least one computer science course compared to roughly 15% and 19% of comparison students. And by the fourth year of college, 42% of *FIRST* alumni reported taking an engineering course and 21% for the comparison group. For computer science in the same year, 34% of the *FIRST* alumni reported taking a computer science course, compared to just 13% among the comparison group.

Engineering and Computer Science Course-Taking Years 1-4 in College

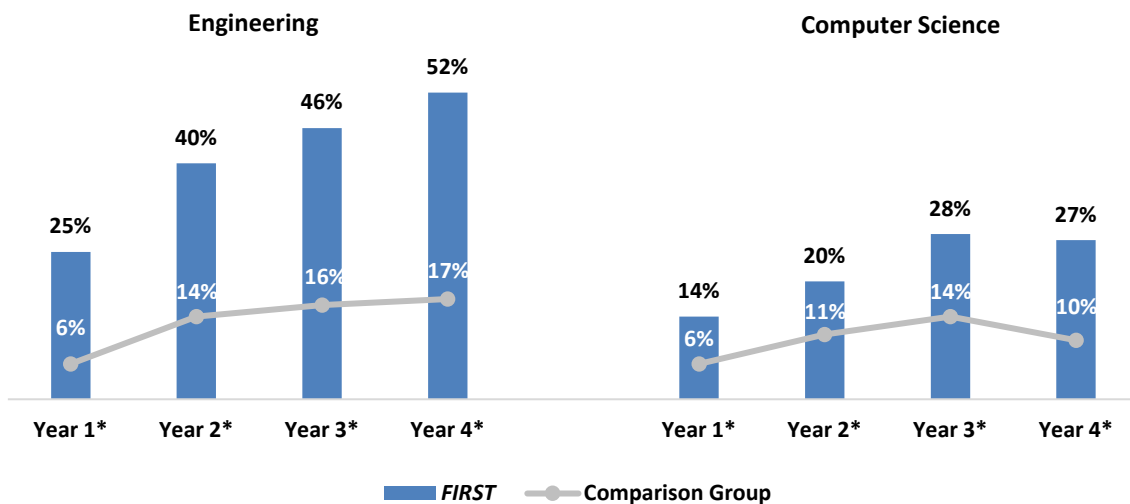


Note: Percentage of full-time students who reported taking at least one course in engineering and/or computer science. Asterisk () indicates statistically significant at $p \leq .05$.*

- In Year 4, *FIRST* alumni were 1.7 times more likely to have taken an engineering course, and 2.4 more likely to have taken a computer science course than the comparison students.
- **Consistent with their greater interest in engineering and computer science majors and increased course-taking in those fields, *FIRST* alumni are significantly more likely than comparison students to declare a major in engineering or computer science. They are also significantly more likely than comparison students to declare a major in a STEM field generally by the end of their fourth year of college.**
 - *Engineering majors:* *FIRST* alumni were significantly more likely to declare a major in engineering in all four years of college than comparison students: 25% vs. 6% in the first year of college, 40% vs. 14% in Year 2, 46% vs. 16% in Year 3, and 52% vs. 17% in Year 4. In Year 4, *FIRST* alumni were nearly twice as likely to major in engineering as comparison students.
 - *Computer science majors:* In all four years of college, *FIRST* alumni declared a major in computer science at a significantly higher rate than comparison students: 14% vs. 6% in the first year of college, 20% vs. 11% in Year 2, 28% vs. 14% in Year 3 and 27% vs. 10% in Year 4. In Year 4, *FIRST* alumni were more than twice as likely (2.4 times) as comparison students to major in computer science.

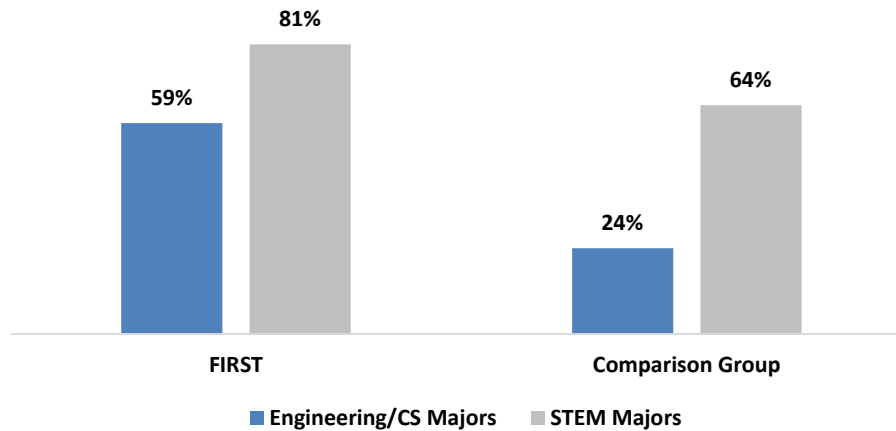
Engineering and Computer Science Majors Years 1-4 of College

(Percent of those who Declared Majors)



Note: Percent of students who declared a major in specified fields as a percentage of all those who declared a major in that year. Asterisk (*) indicates statistically significant at $p \leq .05$.

Engineering/Computer Science Majors & STEM Majors - Year 4



Note: Data represents percentages of those who declared a major in years 1-4 of college. All differences are statistically significant, $p \leq .05$. STEM fields include: biology, computer science, engineering, health professions, mathematics, physical sciences, vocational/ technical fields, and robotics.

- *Engineering/Computer Science: By Year 4, 59% of FIRST alumni had declared a major in either computer science or engineering vs. 24% of students in the comparison group.*
- *STEM majors overall: FIRST alumni were also more likely to declare a major in a STEM field generally. By the end of Year 4 in college, of those who had declared a major, 81% of FIRST alumni overall had declared a major in a STEM-related field compared to 64% of comparison students.*

Gender Differences in College

The impacts on college pathways were shared by both male and female *FIRST* alumni for all three outcome measures at the college level: interest in majoring, course taking, and declaring a major in engineering or computer science. A larger proportion of male and female *FIRST* alumni reported higher degrees of interest in majoring, course taking, and declaring a major in engineering or computer science, although not statistically significant in all years, as detailed below.

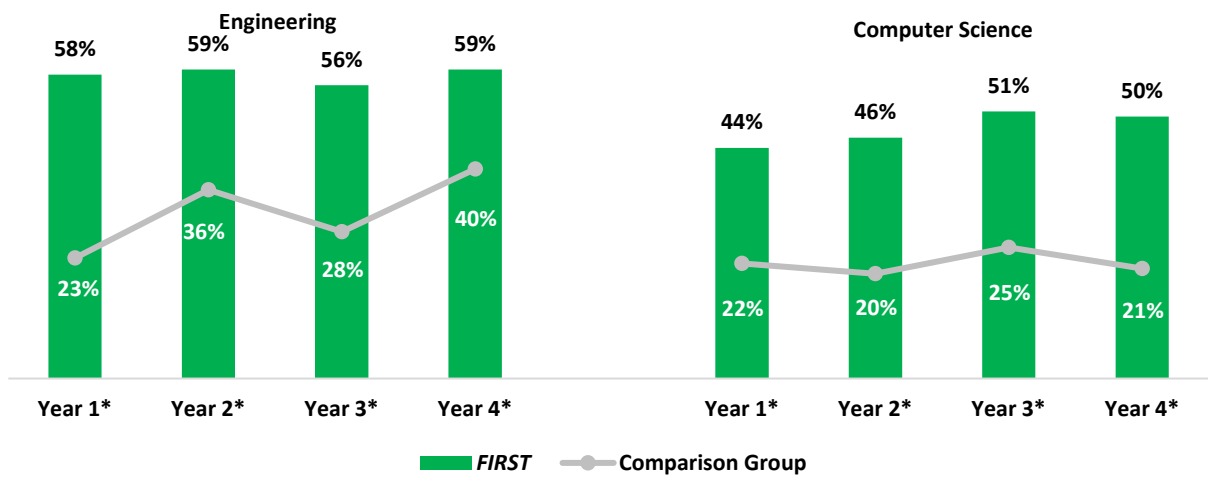
At the same time, the college outcome data show somewhat different patterns of impact between males and females. In general, the gap between *FIRST* and comparison group males in interest in engineering and computer science majors, engineering and computer science course-taking, and declared majors remained the same or narrowed slightly, mostly due to an increase in the comparison group, and these differences are not always statistically significant.

In contrast, **the gap between female *FIRST* alumni and comparison students started to widen, with female *FIRST* alumni significantly more likely to be interested in engineering and computer science, to take engineering and computer science courses, and to major in engineering.** These differences are strongest for engineering. Next, we present these patterns in more detail.

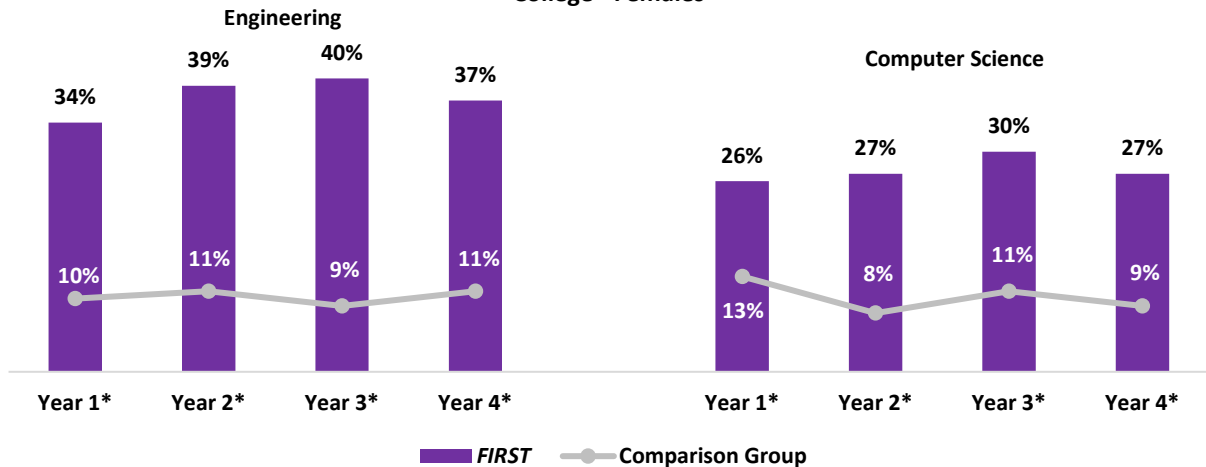
- **While FIRST alumni were significantly more likely to be highly interested in majoring in engineering and computer science than comparison students, the patterns for male and female alumni were different.**

Over four years of college, the gap in interest in engineering majors narrowed between male FIRST alumni and male comparison group members as interest grew among comparison group members; however, the difference in interest remained significant over the course of four years. The same is true of interest in computer science majors. Female FIRST alumni were significantly more interested in both engineering and computer science majors through all four years of college, with the differences in engineering more substantial in comparison to computer science.

Percent "Very Interested" in Engineering and Computer Science Majors in Years 1-4 of College - Males



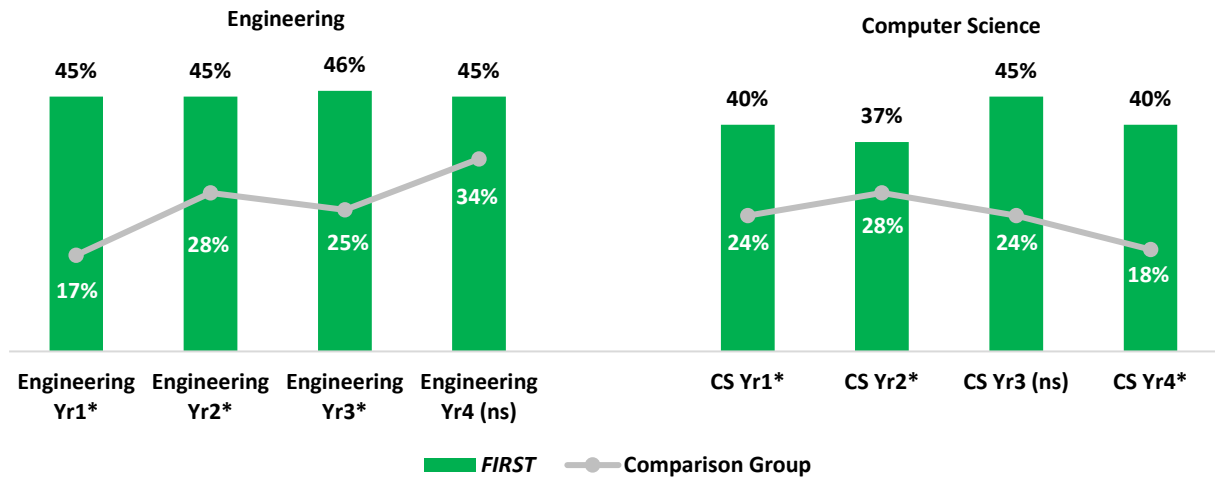
Percent "Very Interested" in Engineering and Computer Science Majors in Years 1-4 of College - Females



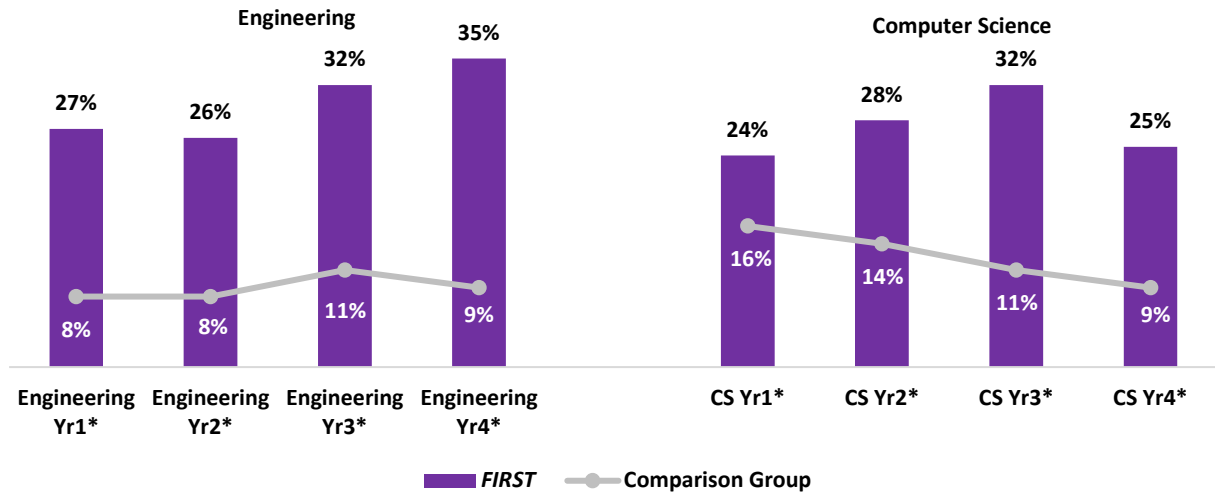
Note: Percent of students who declared a major in specified fields as a percentage of all those who declared a major in that year. Asterisk () indicates statistically significant at $p \leq .05$.*

- Over the first 4 years of college, the gap in engineering and computer science course-taking remained relatively stable and significant for males (not significant in Year 4 for engineering, nor Year 3 for computer science), but grew and became statistically significant between female *FIRST* alumni and comparison young women. By Year 4, the percentages of female *FIRST* alumni taking courses in engineering and computer science were both three times higher than that for young women in the comparison group (35% vs. 9% in engineering and 25% vs. 9% in computer science).

Engineering and Computer Science Course-Taking in Years 1-4 in College - Males



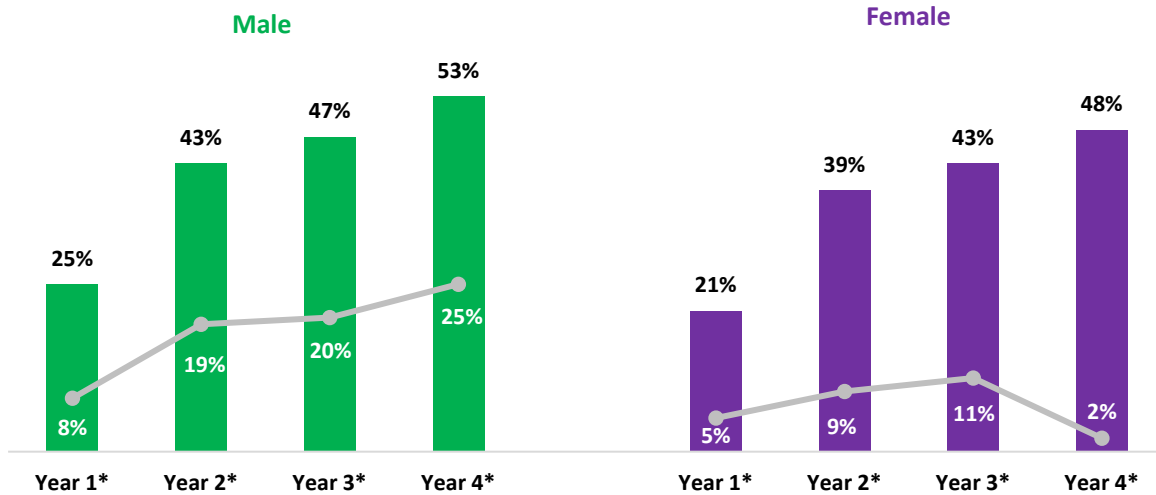
Engineering and Computer Science Course-Taking in Years 1-4 in College - Females



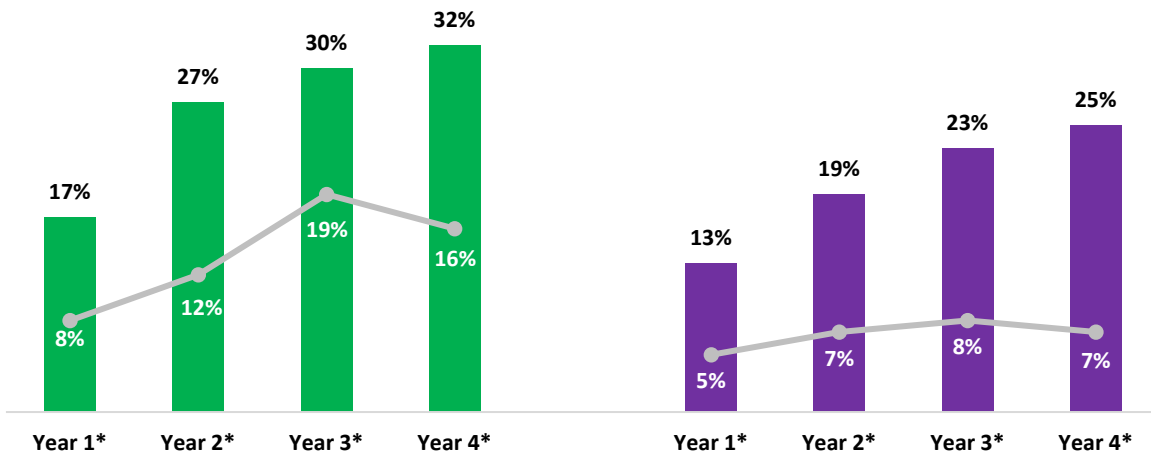
Note: Percentage of full-time students who reported taking at least one course in engineering and/or computer science. Asterisk (*) indicates statistically significant at $p \leq .05$. NS indicates that differences are not statistically significant.

- In terms of declared majors, the gap in declared majors in engineering between male *FIRST* alumni and comparison males narrowed over the four years of college, largely as a result of a substantial increase in engineering majors among comparison males in Year 2. From Years 1 through 4, the difference between male *FIRST* alumni and male comparison group members remained significant.
- Among young women, however, the gap widened substantially, and female *FIRST* alumni continued to declare majors in engineering at a significantly higher rate than women in the comparison group. Notably, by Year 4, 48% of female *FIRST* alumni had declared majors in engineering, a rate twenty-four times higher than female counterparts in the comparison group.

Declared Majors in Engineering, Years 1-4 in College

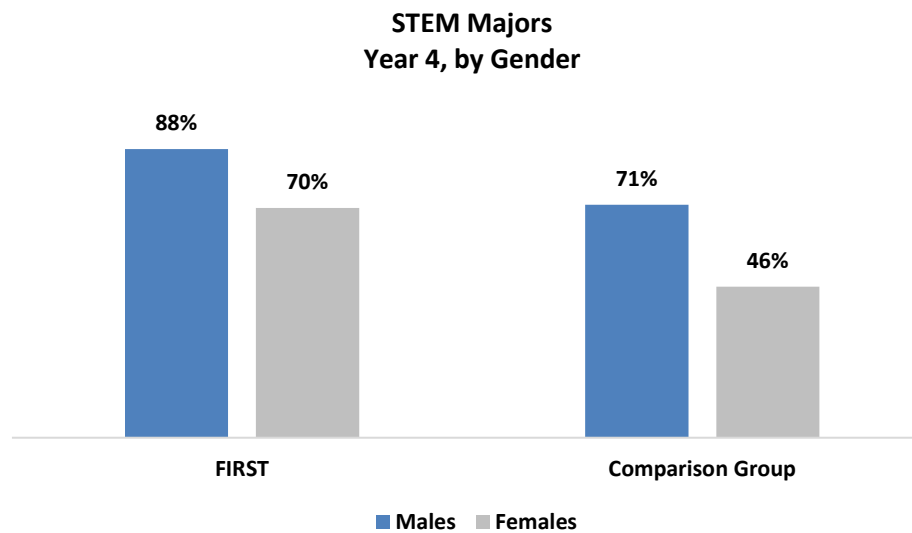
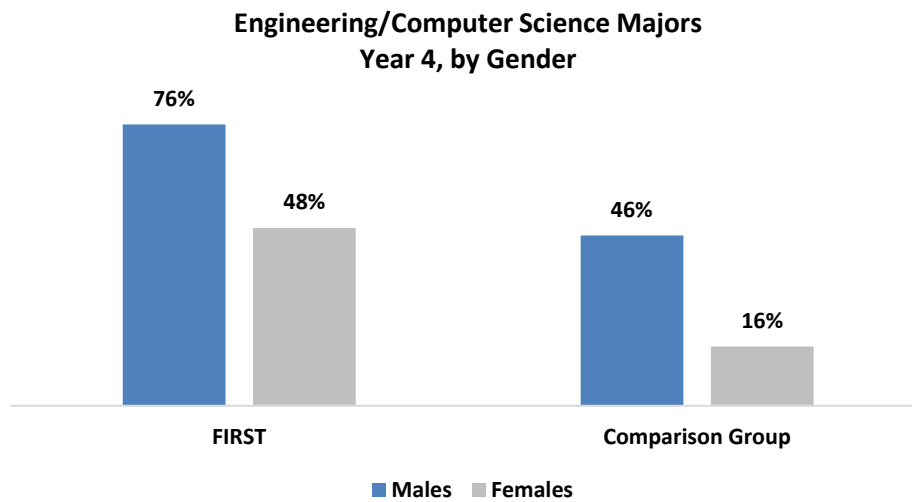


Declared Majors in Computer Science, Years 1-4 in College



Note: Percentage of students who declared a major in years 1-4 of college. Asterisk (*) indicates statistically significant at $p \leq .05$.

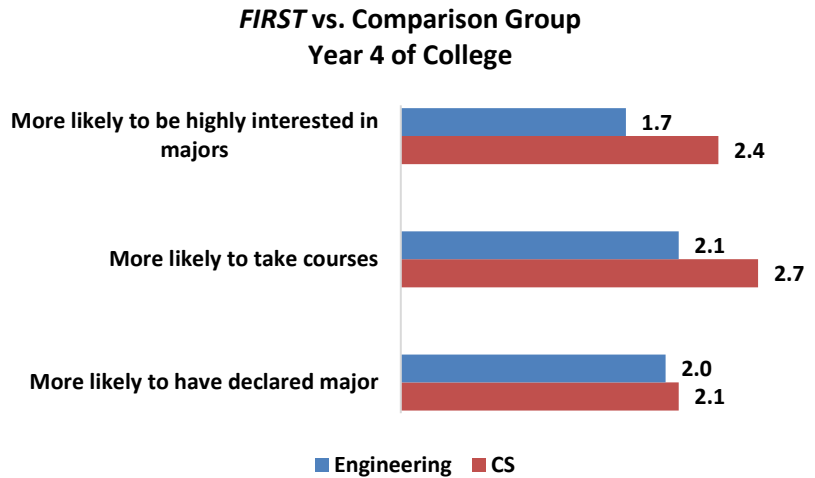
- **In computer science, the pattern was similar:** by Year 4, the gap in computer science majors between female *FIRST* alumni and female comparison students had grown. The differences for *FIRST* males and their comparison group, as well as *FIRST* females and their comparison group, remained significant all four years.
- **Finally, while there are variations between results for male and female *FIRST* alumni when engineering and computer science majors are looked at separately, when engineering and computer science majors are combined and when looking across STEM majors as a whole, both male and female *FIRST* alumni are significantly more likely to major in STEM fields than their comparison group counterparts.** Overall, 76% of male and 46% of female *FIRST* alumni declared a major in engineering or computer science by the fourth year of college (compared to 48% and 16% of comparison students respectively); 88% of male and 70% of female *FIRST* alumni declared a major in a STEM-related field (compared to 71% of male and 46% of female comparison group members).



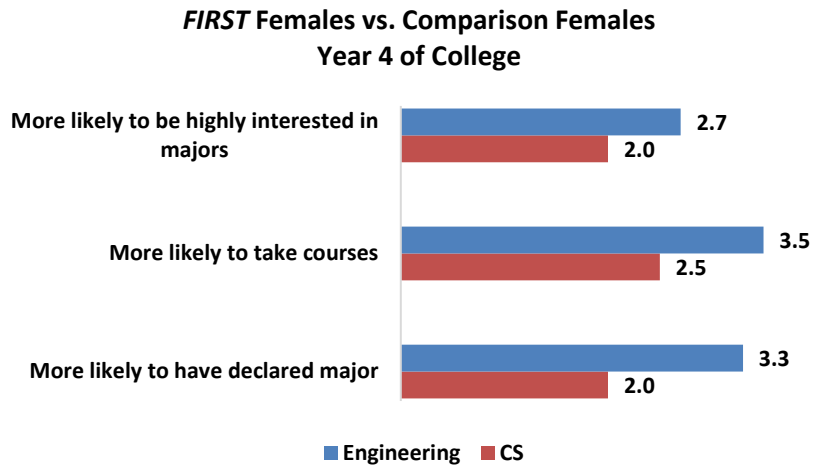
Note: Data represents percentages of those who declared a major in years 1-4 of college. All differences are statistically significant, $p \leq .05$. STEM fields include: biology, engineering, computer science, health professions, mathematics, physical sciences, vocational/ technical fields, and robotics.

In the next section, we examine differences in interest in, taking courses, and majors in Year 4 of college.

- When observing differences between overall group and gender group comparisons, we find *FIRST* females exhibit greater interest in engineering:** In comparison to previous years of analysis, where all *FIRST* and comparison participants showed higher interest, likelihood in course-taking, and likelihood in declaring majors in engineering, the reverse became true at the 96-month follow-up and holds true for the 108-months follow-up. By their 4th year of college, *FIRST* participants as a whole showed greater likelihood in all three areas in computer science, rather than engineering.



- FIRST* females, however, continued to show greater levels of interest in majors, courses, and declaring majors in engineering.** For example, by their 4th year of college, *FIRST* females were nearly more than 3 times (3.5) as likely than comparison females to take engineering courses and 3.3 times as likely to declare an engineering major over the comparison group. In the same years, they were only 2.5 times more likely to take computer science courses and 2.0 times as likely to declare computer science as their major than comparison females.



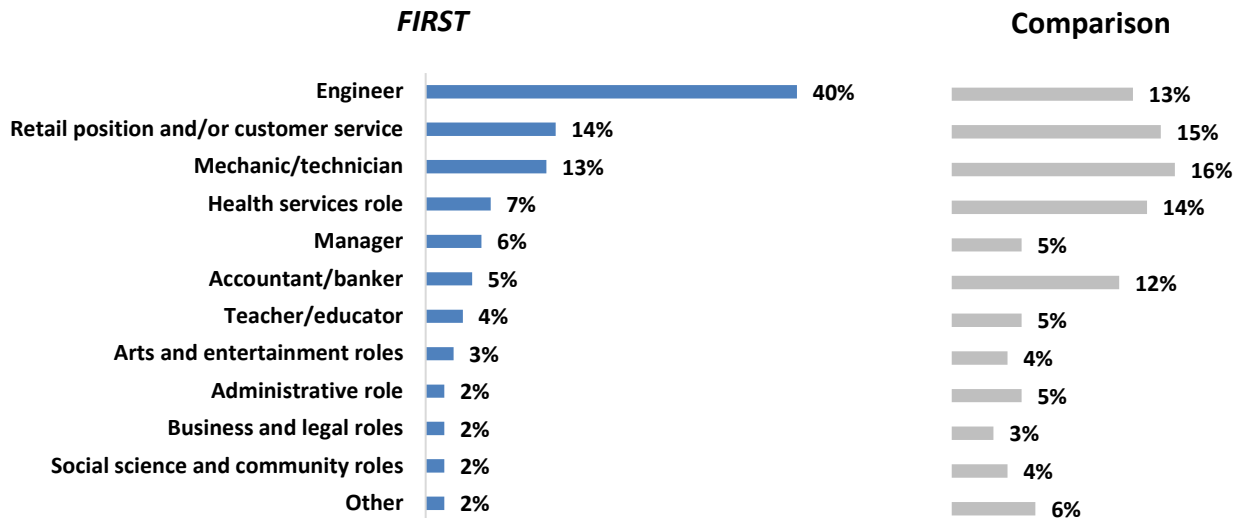
Note: Controlling for Gender, Race, Honors Courses, Family Income, and Parental Support for STEM

Engineering Majors Sub-Fields

We added a question on type of engineering fields selected for college majors to the 108-month survey. Mechanical and electrical engineering are most popular among *FIRST* alumni, and proportionately, comparison group students leaned more towards civil engineering. The comparison group tended to be more interested in biomedical engineering, albeit the small sample sizes do not allow for conclusive results.

Employment in STEM

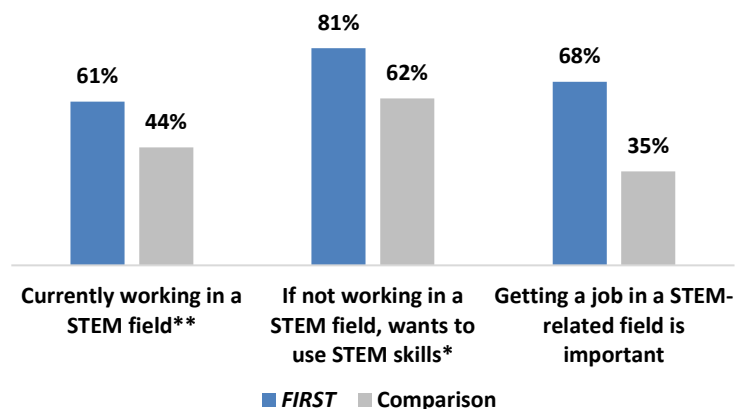
Entering Employment



As the study participants begin to move beyond college, we are interested in their early careers. Above we show differences between *FIRST* and the comparison group along self-identified job titles. *FIRST* alumni are notably more likely to be working as an engineer.

The survey included a series of questions on STEM-related jobs. While the sample of respondents employed post-graduation is still small (total N=398), these results should be treated as preliminary. Regardless, we observe significant differences between *FIRST* alumni and comparison group survey respondents.

***FIRST* alumni are significantly more likely to work in a STEM field** than the comparison group. More than half among them, 61% were working in the STEM field, compared to 44% of comparison group respondents.



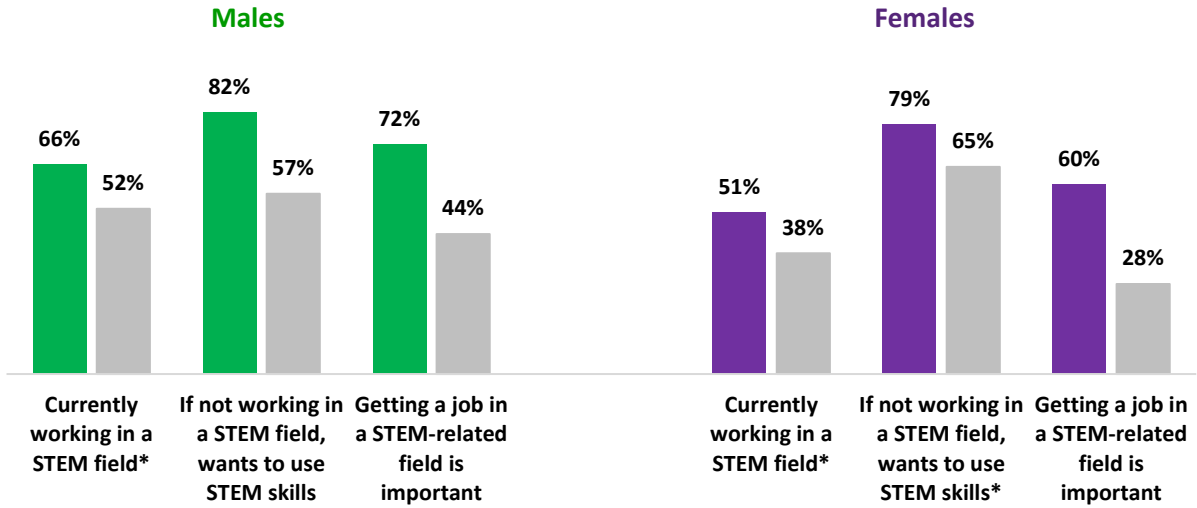
Note: Differences are statistically significant at $p \leq .05$. (*) or $p \leq .01$. (**).

For those not working in a STEM field, ***FIRST* alumni are significantly more likely to want to work in STEM** and to use their STEM skills. 81% among them reported wanting to work in STEM, compared to 62% among comparison group respondents.

Regardless of working or not working in a STEM field, ***FIRST* alumni are more likely to report that getting a job in a STEM field as important** to them, though the difference to comparison participants is not

statistically significant, most likely due to the small sample size for this question. 68% among them reported a STEM job as important, compared to 35% among comparison group respondents.

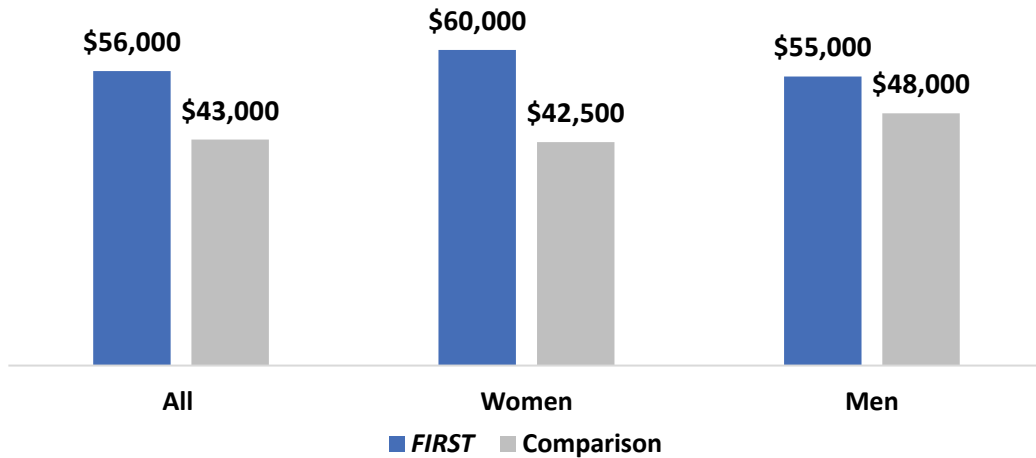
We observe similar trends for male and female *FIRST* alumni. For both groups, *FIRST* alumni are significantly more likely to work in a STEM field. In addition, ***FIRST* females are significantly more interested in wanting to use their STEM skills when currently not working in a STEM field.** For both groups, getting a job in a STEM field is not significantly different from the comparison group.



Note: Differences are statistically significant at $p \leq .05$. (*).

Median Annual Income

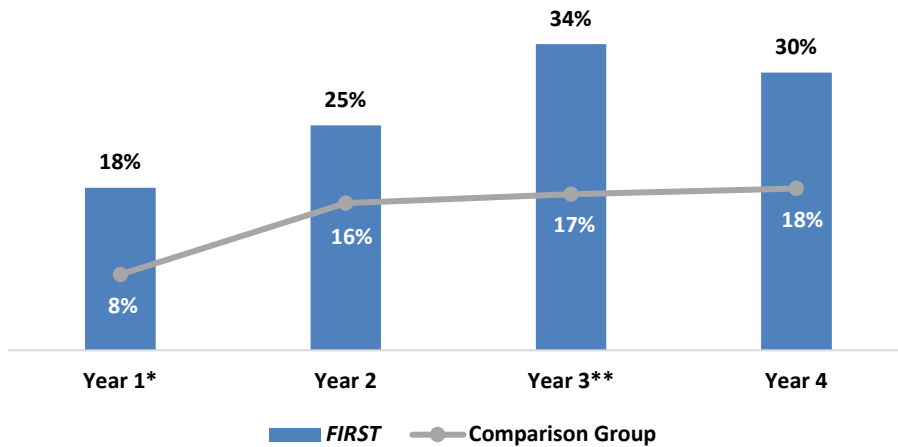
For those employed, we compared their median annual income and found overall higher incomes for *FIRST* alumni. These differences are however not statistically significant.



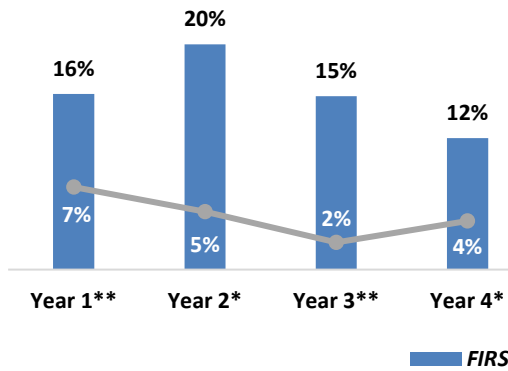
STEM-Related Activities

In each year of college, *FIRST* students were significantly more likely to participate in STEM-related activities than the comparison group. While the gap decreased slightly in regards to participation in STEM internships, *FIRST* participants still engaged in these activities at least 1.5 times more than comparison participants. For computer and engineering clubs, however, *FIRST* participants not only participated at much higher rates than the comparison group, but did so in a manner that widened the gap substantially. Differences were statistically significant for internships, computer, and engineering clubs.

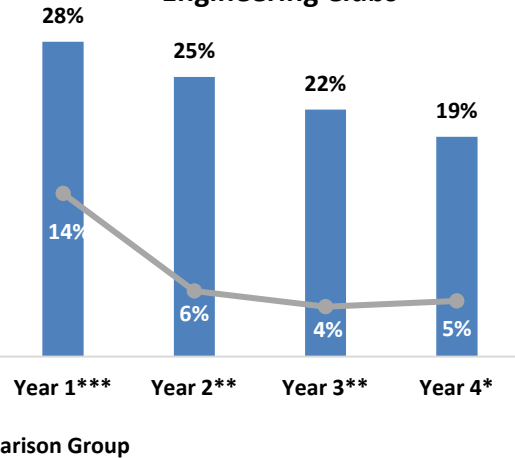
STEM-Related Internships



Computer Clubs

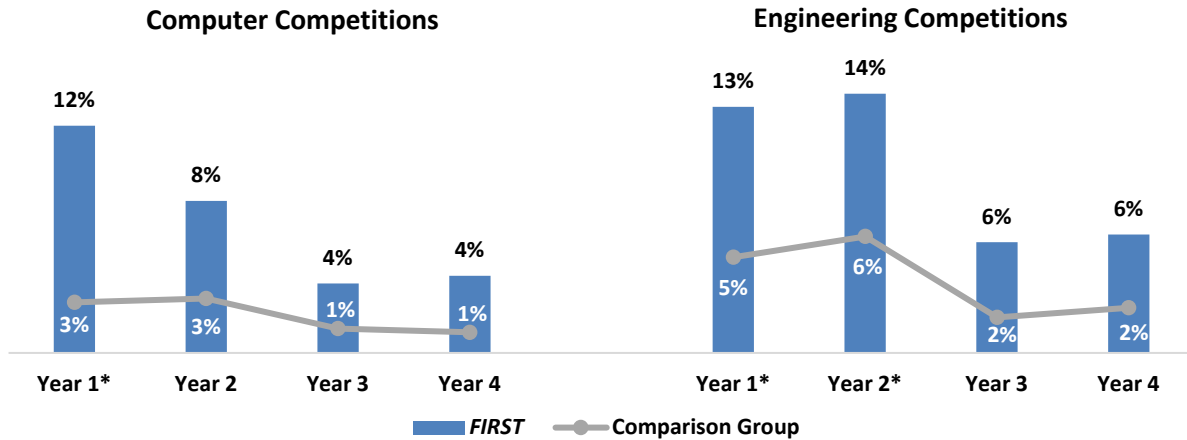


Engineering Clubs



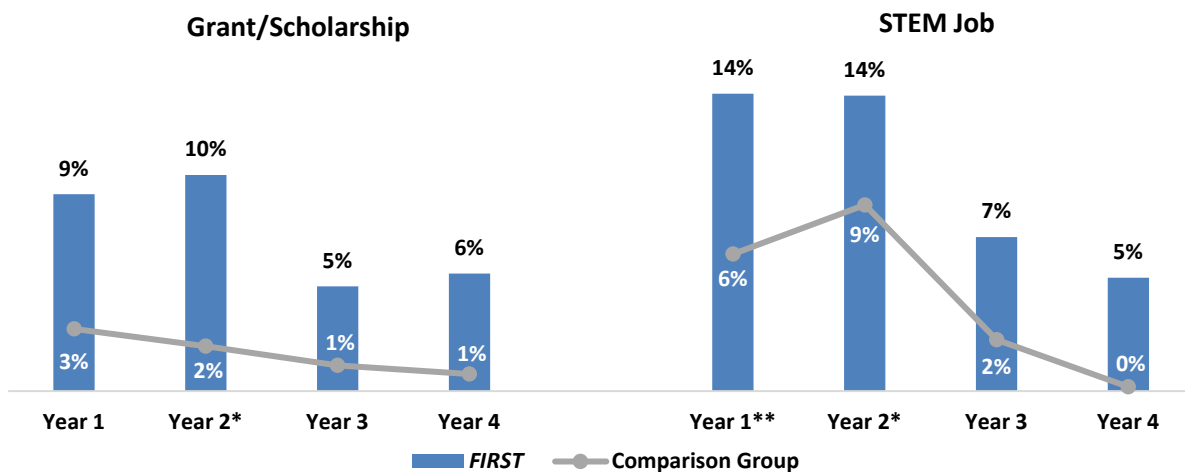
Note: Differences are statistically significant at $p \leq .05$. (*) or $p \leq .01$. (**).

FIRST alumni are also significantly more likely to participate in computer and engineering competitions. Gaps between *FIRST* and comparison group participants remained wide over the course of all four years, and increased over time.



Note: Differences are statistically significant at $p \leq .05$ (*) or $p \leq .01$ (**).

In regards to STEM-related scholarships and jobs, *FIRST* participants were once again significantly more likely to receive engineering-related grants or scholarships, and to work in a STEM-related summer job.



Note: Differences are statistically significant at $p \leq .05$ (*) or $p \leq .01$ (**).

Very few comparison group participants received grants or scholarships in STEM fields, and were similarly engaged in STEM-related jobs to a low degree; in the case of the 4th year of college, no comparison group students worked in such positions.

Membership in Professional Organizations and Professional Certification

Among those currently employed, comparison group participants were significantly more likely to report membership in professional organizations and to have acquired a professional certificate.

	FIRST	Comparison Group
Membership Professional Organizations*	9.2%	23.8%
Professional Certification**	20.8%	25.4%

Note: Differences are statistically significant at $p \leq .05$. (*) or $p \leq .01$. (**).

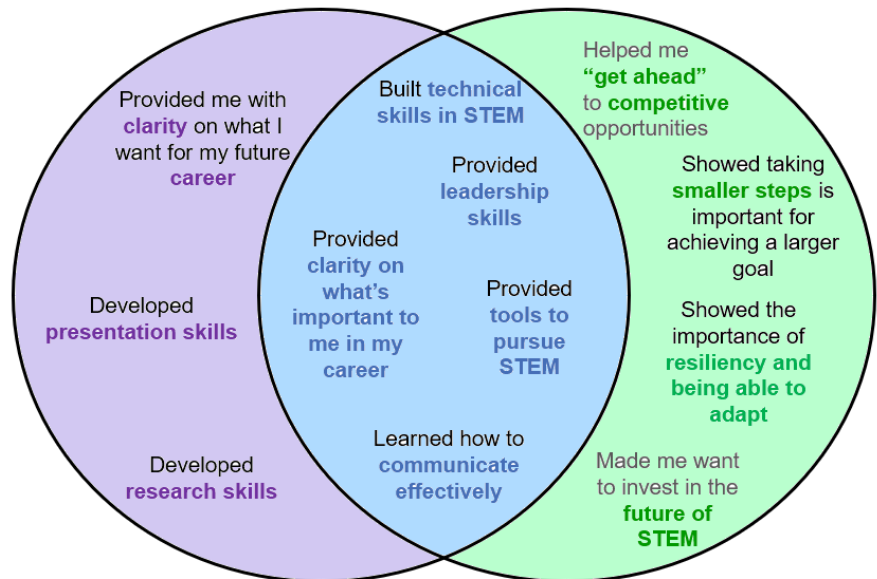
Participants' Assessments on FIRST impacts: Differences by Gender

FIRST participants were asked for an example of how their FIRST experience has made an impact on them. Below is an analysis of differences by gender.

Impacts on Careers

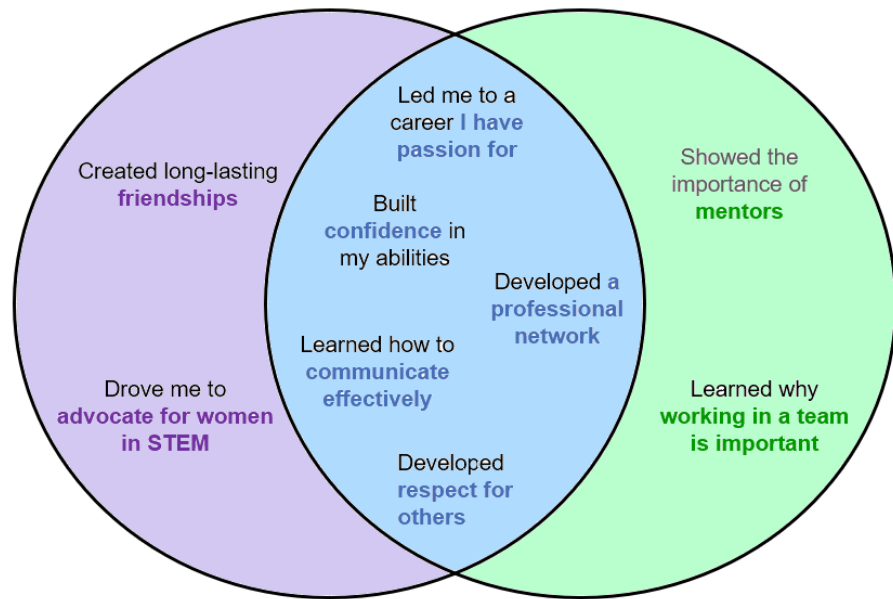
Males and females highlight impacts of FIRST on their careers, with some overlap but also notable differences. Overlap of themes included gaining of STEM skills, leadership and communication skills in professional capacities, and resources for pursuing STEM fields. Both groups also discussed gaining a clearer sense of what they wanted to prioritize in their career.

FIRST female alumni highlighted that FIRST taught them research and presentation skills. FIRST women also discussed having gained a better understanding of what it was that they wanted to incorporate into their future career, as a result of their participation in the program. For males, commonly mentioned areas included gaining skills in resiliency and developing road maps towards larger goals, developing an investment in the future of STEM fields, and gaining academic and professional opportunities that would give them a competitive advantage later in their career.



Impacts on Interpersonal Skills

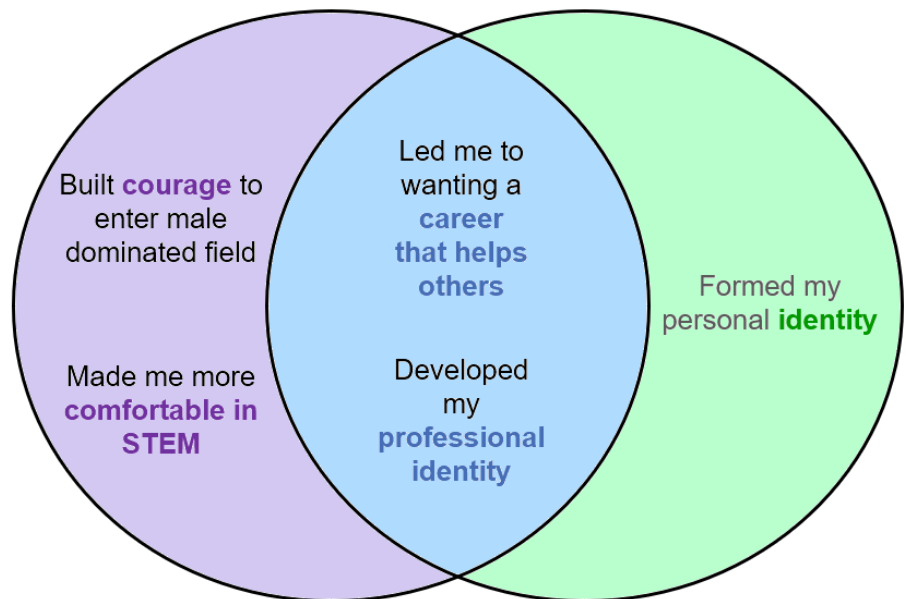
FIRST males and females discussed the ways their program experience influenced their interpersonal skill development. While females often mentioned the ways *FIRST* led to their gaining of new friendships, as well as a desire to advocate for women in STEM fields, males learned about the importance of teamwork and mentorship. Both females and males gained more confidence, communication skills, and mutual respect for others;



and found themselves in careers in which they felt emotionally invested. Both groups also discussed how *FIRST* helped them develop professional networks, and how the process of forming such networks improved their social skills.

Impacts on Identity

FIRST program participation influenced male and female participants' identity developments. Women discussed how their participation allowed them to feel more comfortable in entering STEM fields, cited as being more "male dominated" areas. Men spoke to how *FIRST* impacted their personal identity development, more generally speaking. Both groups felt inspired to pursue careers that would



allow them to engage in more philanthropic efforts and activities, while also feeling as though their professional identities were molded by their *FIRST* experience.

Below, young women describe how their *FIRST* experience made lasting impacts:



“Because of FIRST I was able to see how an engineer would work with different people. I also learned how to build and design. If it wasn’t for FIRST I probably wouldn’t have picked engineering as a career path.”

“Being able to work in a team and under pressure.”

“Emphasis on lifting everyone up around you, creating opportunities and sharing knowledge is huge for me. I apply it day to day in whatever I do. I hope to help people grow and be successful.”

“FIRST has given me a group of amazing friends that I still speak to today and, as a mentor, it gives me the ability to network and meet new people who are interested in science, education, and other interests of mine. As a female, I’ve had to deal with quite a few instances of misogynistic people within FIRST that believe I can’t do certain things because I don’t have enough experience or they just generally think they are more qualified than me – these experiences have made me want to advocate for girls in STEM and has been an integral part of why I am in science and mentoring today.”

“FIRST has given me the courage to pursue a male dominated industry and gain a degree in the field.”

“It helped with my leadership and public speaking skills. In my nonprofit service organization, I often have to give speeches and make presentations, skills I worked on during my involvement with FIRST.”

Conclusions

Nine years after entering *FIRST*, program participants continue to show consistently greater STEM-related interests and attitudes than similarly positioned students in the comparison group. Positive impacts on STEM-related attitudes and interests are evident across all three *FIRST* programs in the study and across all of the major population groups. The impact of *FIRST* on STEM-related attitudes is particularly strong for female participants who generally show significantly greater levels over the comparison group than those experienced by male program participants. Data on students through their first four years of college show that the positive impacts of *FIRST* on STEM-related attitudes and interests continue into postsecondary education, with *FIRST* alumni continuing to show positive impacts on STEM-related attitudes through the fourth year of college.

For those in college, the data from the study also show that *FIRST* has a positive impact on students’ engagement in college pathways in engineering, computer science, and STEM-related fields in general. Through the fourth year in college, *FIRST* alumni are significantly more likely to be interested in technology-related majors, take courses in engineering and computer science, and declare majors in engineering, computer science, and STEM-related fields more broadly. Here, too, while both male and female *FIRST* alumni show positive impacts on interest, course-taking and declared majors, the results for female *FIRST* alumni are particularly strong, with female alumni consistently engaging in STEM-related fields at a rate significantly higher than female comparison students.

Preliminary data on employment post college highlight the impact of *FIRST*. A larger proportion of *FIRST* alumni work in a STEM field and report that getting a job in a STEM field is important. Eighty-one percent of *FIRST* alumni currently not working in a STEM field report wanting to use their STEM skills.

While the study will continue to follow students through postsecondary education and their early post-graduation careers, the results to date already indicate that *FIRST* is making a lasting difference in career interests and educational choices for the young people who participate in the program.

Appendix

Study Background

FIRST[®] (For Inspiration and Recognition of Science and Technology) is a global nonprofit organization that operates after-school robotics programs for young people ages 4-18 in the United States and internationally. The mission of *FIRST* is to inspire young people to be science and technology leaders by engaging them in exciting mentor-based programs that build science, engineering and technology skills, inspire innovation, and foster well-rounded capacities including self-confidence, communication, and leadership. *FIRST* programs include *FIRST* LEGO League Discover (ages 4-6), *FIRST* LEGO League Explore (ages 6-10) and *FIRST* LEGO League Challenge (ages 9-14), *FIRST*[®] Tech Challenge serving grades 7-12, and *FIRST*[®] Robotics Competition, serving high school-aged youth (grades 9-12). *FIRST* estimates in 2019-2020, the programs reached over 679,000 young people worldwide.¹

In 2011, *FIRST* contracted with the Center for Youth and Communities at Brandeis University's Heller School for Social Policy and Management to conduct a multi-year longitudinal study of *FIRST*'s middle and high school programs. The goal of the study, building on more than a decade of short-term evaluation studies by Brandeis University and others, is to document the longer-term impacts of *FIRST* programs on participating youth and to do so through a design that meets the standards for rigorous, scientifically-based evaluation research. Three major questions guide the study:

- **What are the short and longer-term impacts of the *FIRST* LEGO League, *FIRST* Tech Challenge, and *FIRST* Robotics Competition programs on program participants?** Specifically, what are the program impacts on a core set of participant outcomes that include: interest in STEM and STEM-related careers, college-going and completion, pursuit of STEM-related college majors and careers, and development of 21st century personal and workplace-related skills?
- **What is the relationship between program experience and impact?** To what extent are differences in program experience – such as time in the program, participation in multiple programs, role on the team, access to mentors, quality of the program experience – associated with differences in program outcomes? What can we learn about “what works” to guide program improvement?
- **To what extent are there differences in experiences and impacts among key subpopulations of *FIRST* participants?** In particular, are there differences in impacts for young women, youth of color, low-income youth, and youth from urban or rural communities? If there are differences, what can we learn about why those differences occur and their implications for the program in the future?

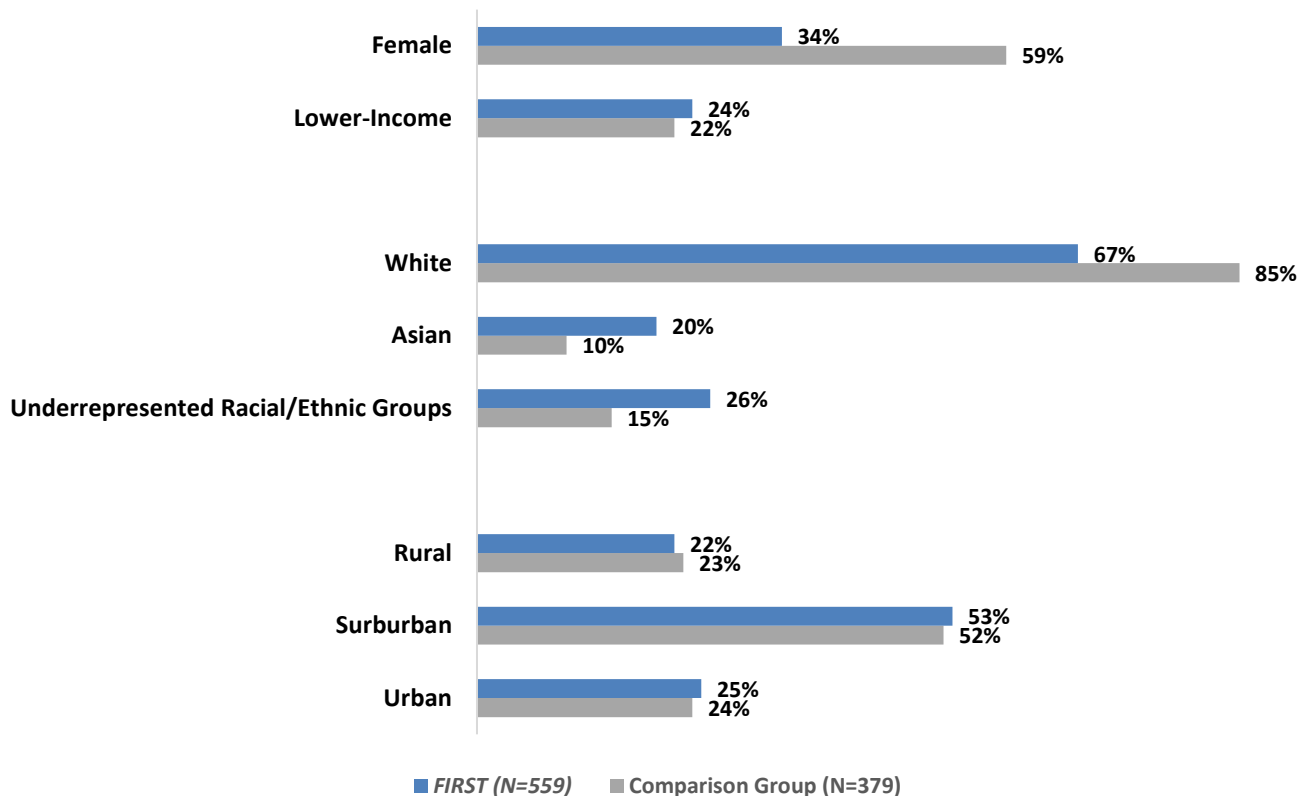
To address these questions, the *FIRST* Longitudinal Study has been tracking 1,273 students (822 *FIRST* participants and 451 comparison students) over a nine-year period beginning with entry of the *FIRST* participants into the program. Team members were recruited to the study from a nationally representative sample of “veteran” teams from the *FIRST* LEGO League, *FIRST* Tech Challenge, and *FIRST* Robotics Competition programs over a two-year period spanning the 2012-13 and 2013-14 school years. Comparison group students were recruited from math and science classes in the same schools and

¹ <http://www.firstinspires.org/about/at-a-glance>

organizations where the *FIRST* teams were located. Once recruited into the study, team members and comparison students were surveyed at baseline and post-program in their first year, with annual follow-up surveys each spring thereafter. A baseline survey of parents provided additional background information on the family context for team members and comparison students, and Coach/Mentor surveys at the end of the first year of team involvement in the study provided additional contextual data on the *FIRST* teams. In several study years, team member surveys have also been supplemented by interviews and focus groups with team members and comparison group students.

Below we show the baseline characteristics at the 108-months follow-up survey for the *FIRST* participant and comparison groups. Overall, both groups match well. The comparison group has more female students and more White respondents than we find among the *FIRST* participants. We control for all these differences in our analyses.

Participant Characteristics at 108 months



ⁱ This report is based on data from the ninth round of follow-up surveys, which were administered approximately 108 months after students entered the study (baseline).

ⁱⁱ Of the 570 *FIRST* participants responding to the 108-month follow-up survey, most (486 had graduated high school, 4 left without a high school degree) were no longer eligible for *FIRST*. Eighty respondents were still in high school but no longer active in the program and 16 among them were still active in *FIRST*.

ⁱⁱⁱ Note: Throughout this summary, “impact” refers to the differences in outcomes between *FIRST* participants and corresponding members of the comparison group, after controlling for differences between the two groups on key measures at baseline. For example, impacts for *FIRST* participants as a whole are based on the difference in outcomes between all *FIRST* participants and all comparison group members; impacts for female *FIRST* participants are based on the comparison with female members of the comparison group. Impacts that are “statistically significant” are those that are large enough to be unlikely to have occurred by chance (less than a 5% probability).

^{iv} Based on “Linear Mixed Models” analysis (“Mixed”). The “mixed” analysis estimates average differences for participants vs. comparison students taking into account differences between the groups at baseline and using data from all available points in time (baseline, post-program, and follow-ups). In this instance, the “mixed” results measure whether the average levels for *FIRST* participants were greater than those experienced by comparison students and whether the differences were large enough to be statistically significant. The effect size (omega squared - ω^2) was “large” for the impact on STEM interest and “medium” for the other STEM outcome measures. Control variables are gender, race, any honors course, parental income, and parental support for STEM.

^v Based on “Logistic Regression” analysis (“Logit”). Logit analysis estimates the relative probability that participants and comparison students will achieve a particular outcome, after controlling for differences between the groups at baseline, including gender, race, any honors course, parental income, parental support for STEM, and interest in STEM at baseline. In this case, the Logit analysis measures whether *FIRST* participants are more (or less) likely than comparison students to show an increase from baseline to follow-up on each STEM-related measure (such as STEM interest) and whether those differences are statistically significant (i.e., unlikely to occur by chance). The “odds ratio” is the measure of the relative likelihood that *FIRST* participants will achieve that outcome (for example, “2.0 times more likely to show higher levels in STEM interest than comparison students”).