

***FIRST* Longitudinal Study:
Findings at 48 Month Follow-Up
(Year 5 Report)**

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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 6-18 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, that inspire innovation, and that foster well-rounded capacities including self-confidence, communication, and leadership. The sequence of *FIRST* programs in the United States begins with the *FIRST*® LEGO® League Jr. program serving elementary school-aged youth (ages 6-9), followed by the *FIRST*® LEGO® League program serving primarily middle school-aged youth (ages 9-14), the *FIRST*® Tech Challenge serving grades 7-12, and *FIRST*® Robotics Competition, serving high school-aged youth (grades 9-12). In 2017-18, *FIRST* estimates that over 515,000 young people will participate in its programs on more than 59,000 teams and will compete in more than 2,900 events worldwide.²

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*'s 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?

KEY FINDINGS AT 48 MONTH FOLLOW-UP

- Follow-up data show *FIRST* continues to have a positive impact on participants on key STEM-related measures at 48 months, including interest in STEM, involvement in STEM-related activities, STEM identity, STEM knowledge, and interest in STEM careers. *FIRST* team members are 1.6 to 3.0 times more likely to show gains on STEM-related outcomes than students in the comparison group.
- The data show positive impacts for participants from all three *FIRST* programs in the study (*FIRST* LEGO League, *FIRST* Tech Challenge, and *FIRST* Robotics Competition), and for all major population groups and community types. Girls in *FIRST* continued to show significantly greater impacts than their male counterparts. Impacts persist for team members even after they leave the program.
- Impacts on STEM-related attitudes and interests persist into college. Among first-year college students *FIRST* alumni:
 - continue to show significantly greater gains on STEM-related attitudes than comparison students.
 - report significantly higher interest in majoring in computer science, engineering, and robotics.
 - are 2.3 times more likely to take an engineering course in their freshman year; girls are 3.4 times more likely to take engineering courses.
 - are more likely to be engaged in STEM-related activities, including STEM internships, computer and engineering clubs, engineering competitions, having STEM-related summer jobs; and receiving engineering-related grants.

¹ This report is based on data from the fourth round of follow-up surveys, which were administered approximately 48 months after students entered the study (baseline).

² <http://www.firstinspires.org/about/at-a-glance>

- **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, non-white youth, low-income youth, and youth from urban 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 is tracking 1,273 students (822 *FIRST* participants and 451 comparison students) over a five-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 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 Team Leader surveys at the end of the first year of team involvement in the study provided additional contextual data on the *FIRST* teams. In each year of the study, team member surveys have also been supplemented by interviews and focus groups with team members and comparison group students.

Impacts at 48 Month Follow-Up

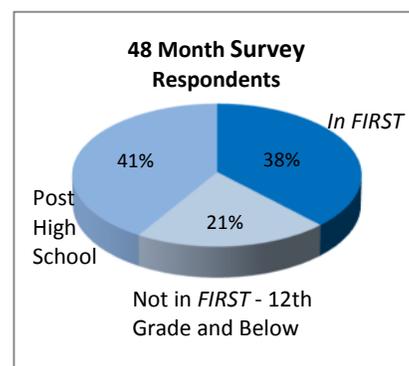
This report presents a summary of the impact findings based on four years of data, including survey data from baseline and post-program surveys and three rounds of annual follow-up surveys. As such, it reflects the impacts of participation in *FIRST* four years after study participants entered the program. Of the 1,273 students who began the study, 1,017 students (80%) completed the 48 month follow-up survey, including 611 *FIRST* participants (74% of those at baseline) and 406 comparison students (90% of those at baseline). Of the *FIRST* participants responding to the follow-up survey, 231 (38%) were still active in the program.³

The findings from the data from the 48 month follow-up surveys extend the positive impact findings from the 2015-2017 impact reports: *FIRST* participants continue to show significantly *greater* average gains on STEM-related attitudes and interests than comparison students and are statistically significantly *more likely* to show gains in STEM-related outcomes than students in the comparison group. These positive impacts hold true for participants from all three

Data Collection through 48 Month Follow-Up

GROUP	Baseline	12 Month Follow-Up (Post-Program)	24 Month Follow-Up	36 Month Follow-Up	48 Month Follow-Up
<i>FIRST</i> Participants	822	677	665	636	611
Comparison Group	451	259*	411	409	406
Total	1273	936	1076	1045	1017

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



³ Of the 380 *FIRST* participants no longer active in the program at the 48 month follow-up, 252 had graduated high school and were no longer eligible for *FIRST*; 128 were still in middle or high school but no longer active in the program. Overall, 64.3% of those eligible to participate in *FIRST* were still active in the program.

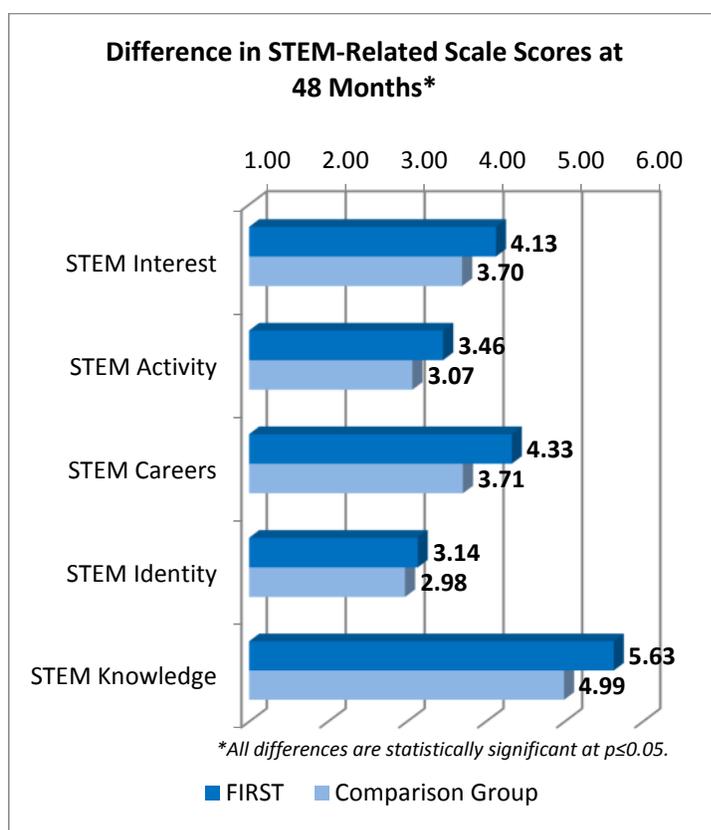
major *FIRST* programs (*FIRST* LEGO League, *FIRST* Tech Challenge, and *FIRST* Robotics Competition), across key demographic groups, and for those living in different types of communities (urban, rural, suburban).⁴ Data on students in their first year of college also point to positive, statistically significant longer-term impacts. In their first year of college, *FIRST* alumni continue to show stronger STEM-related attitudes and interests than comparison students; are more interested in majoring in key STEM-related fields (computer science, engineering, and robotics); are more likely to take engineering courses during their freshman year; and are more likely to be engaged in other STEM-related activities. In most cases, these college impacts are evident for both male and female *FIRST* alumni. Major findings are summarized below.

Impacts on STEM-Related Attitudes (All Participants)

At 48 months, *FIRST* continues 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 1.6 to 3.0 times more likely to show gains on STEM-related measures four years after entering the program than students in the comparison group.

- ***FIRST* participants continue to show significantly greater average gains than members of the comparison group on all of the measures of STEM-related interests and attitudes.** 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.⁵ The STEM-related measures include:

- *interest in STEM,*
- *involvement in STEM-related activities,*
- *interest in STEM careers,*
- *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,” “I can use math and science to make a difference in the world).



⁴ 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).

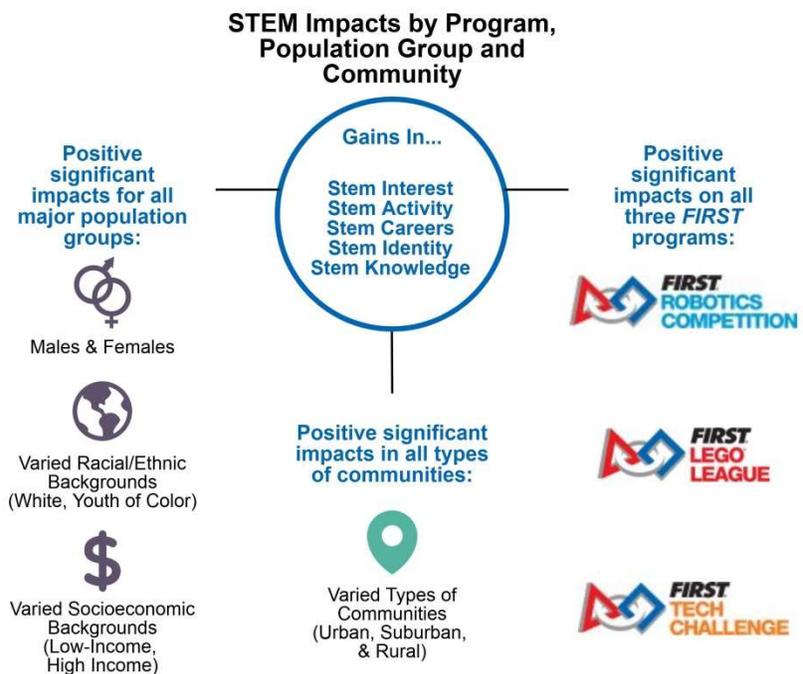
⁵ Based on “Repeated Measures Linear Mixed Models” analysis (“Mixed”). The “mixed” analysis estimates average gains for participants vs. comparison students taking into account differences between the groups at baseline and using data from all available points in time (baseline, post-program, and follow-ups). In this instance, the “mixed” results measure whether the average gains 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 was “large” for the impact on STEM interest and “medium” for the other STEM outcome measures.

- **FIRST participants are also significantly more likely to show an increase on STEM-related measures than comparison students between baseline and the 48 month follow-up.**⁶ After adjusting for differences in baseline characteristics and baseline scale scores, *FIRST* participants were:
 - 3.0 times more likely than comparison students to show gains on *STEM interest*;
 - 2.2 times more likely to show gains in involvement in *STEM activity*;
 - 3.0 times more likely to show gains on interest in *STEM careers*;
 - 1.6 times more likely to show gains in *STEM identity*; and
 - 2.4 times more likely to show gains in *STEM knowledge/understanding of STEM*.

In sum, despite entering *FIRST* with a strong initial interest in STEM, *FIRST* participants were still significantly more likely than comparison students to show continued gains in STEM interest and involvement over time.

- **The 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, FIRST Tech Challenge, FIRST Robotics Competition).** Participants in all three *FIRST* programs show significantly greater gains on STEM-related measures than comparison students.

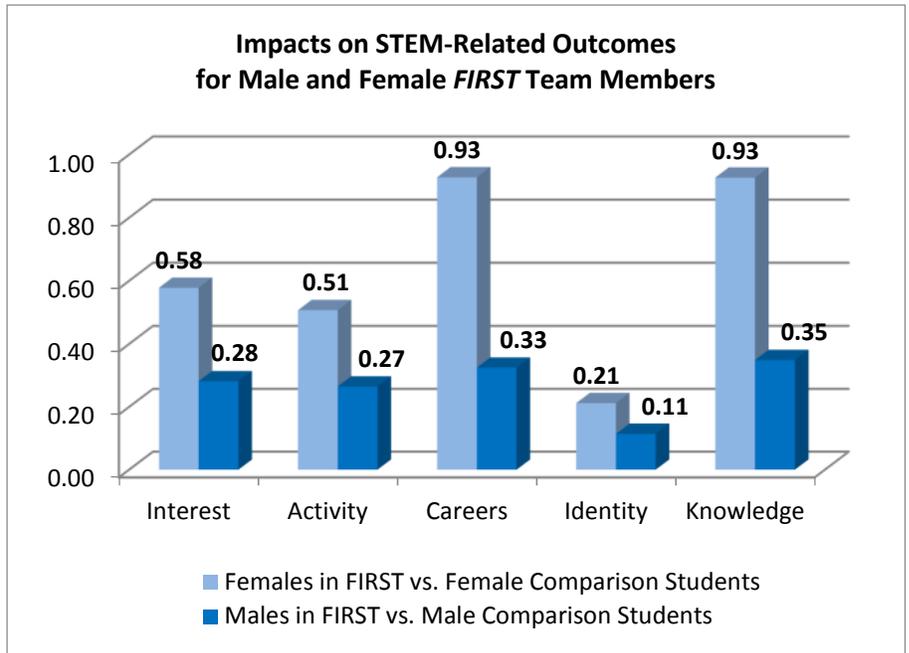
- **STEM-related impacts are also evident across all major population groups and among students from different types of communities (compared to similar students in the comparison group).** Each of the following groups – males and females, lower and higher income students (family incomes below and above \$50,000), White youth and youth of color, and urban, suburban, and rural youth – shows significantly greater gains for *FIRST* participants than for comparison students from the same group or community type.



⁶ 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. 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 relatively likelihood that *FIRST* participants will achieve that outcome (for example, “3.0 times more likely to show a gain in STEM interest than comparison students”).

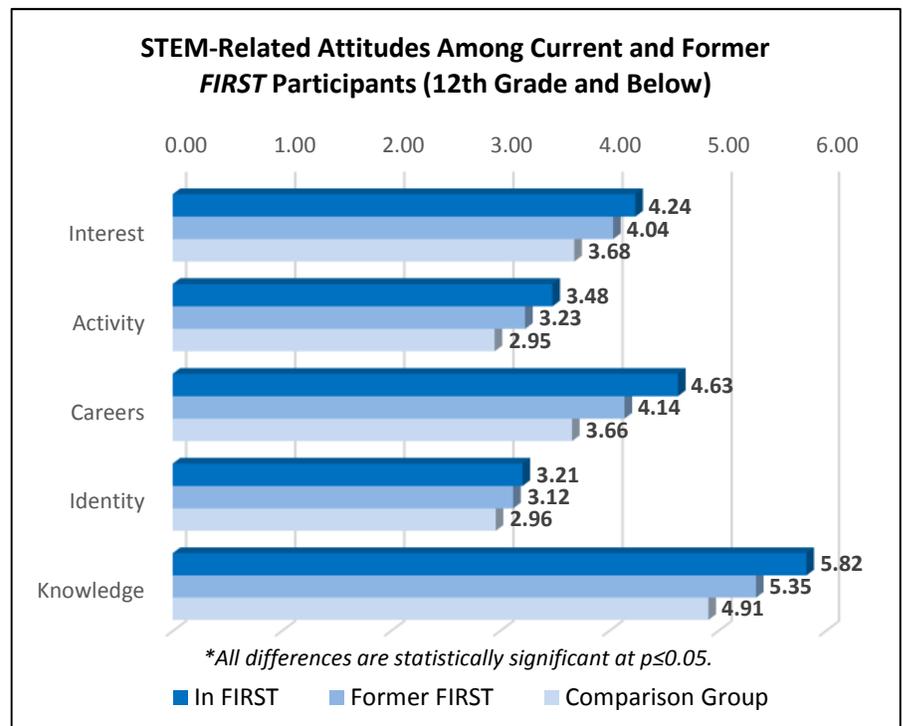
- **While the data show positive impacts for both males and females in FIRST, females continue to show greater impacts than males on all of the STEM-related measures.**

The chart to the right shows the differences in outcomes for females in FIRST compared to females in the comparison group, and for males in FIRST, compared to comparison group males. While all of the differences between FIRST participants and comparison students are statistically significant, the impacts for females in FIRST on each measure are also significantly greater than those for males.



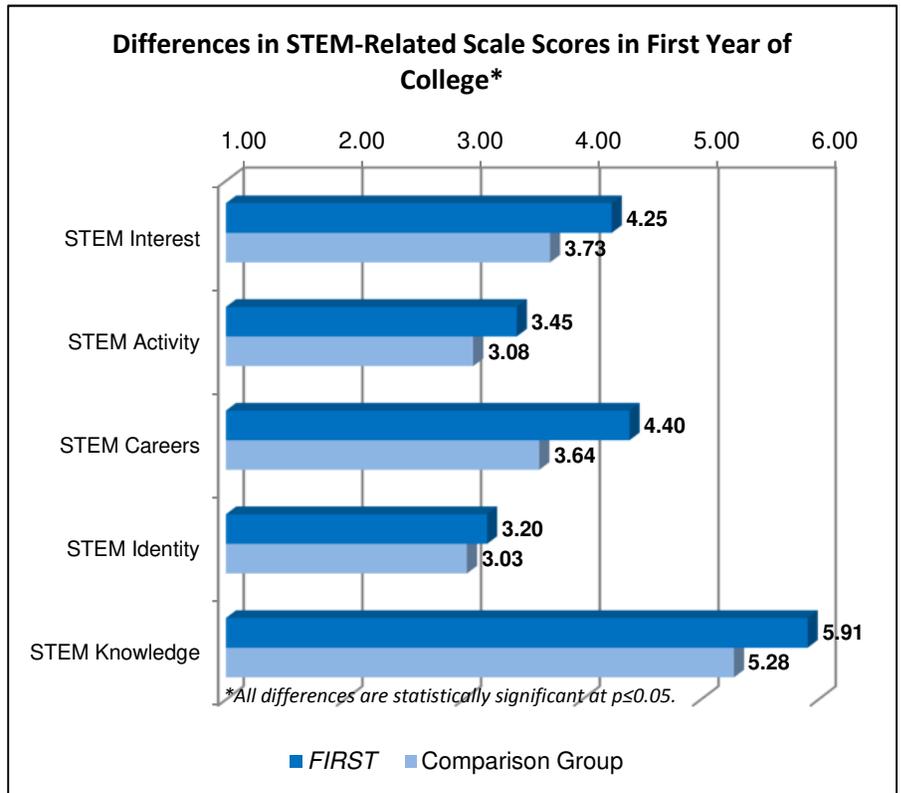
Note: Values on the chart represent the differences in outcomes (estimated scale scores) between FIRST participants and students of the same gender in the comparison groups (i.e., the difference in scores between males in FIRST and males in the comparison group and between females in FIRST and female comparison students). All differences are statistically significant at $p \leq 0.05$. The impacts for females are statistically significantly greater than those for males.

- **FIRST's impacts persist.** Additional analyses show that impacts on STEM-related attitudes persist for FIRST team members even after they have left the program. Among study participants still in secondary school (12th grade and below), both current and former FIRST participants show statistically significant gains on STEM measures as compared to students in the comparison group. Team members still active in FIRST show the greatest gains, but those who have left the program continue to show significantly greater gains than comparison students. Similarly, students who participate in FIRST for only one year continue to show positive impacts relative to comparison students at 48 months.

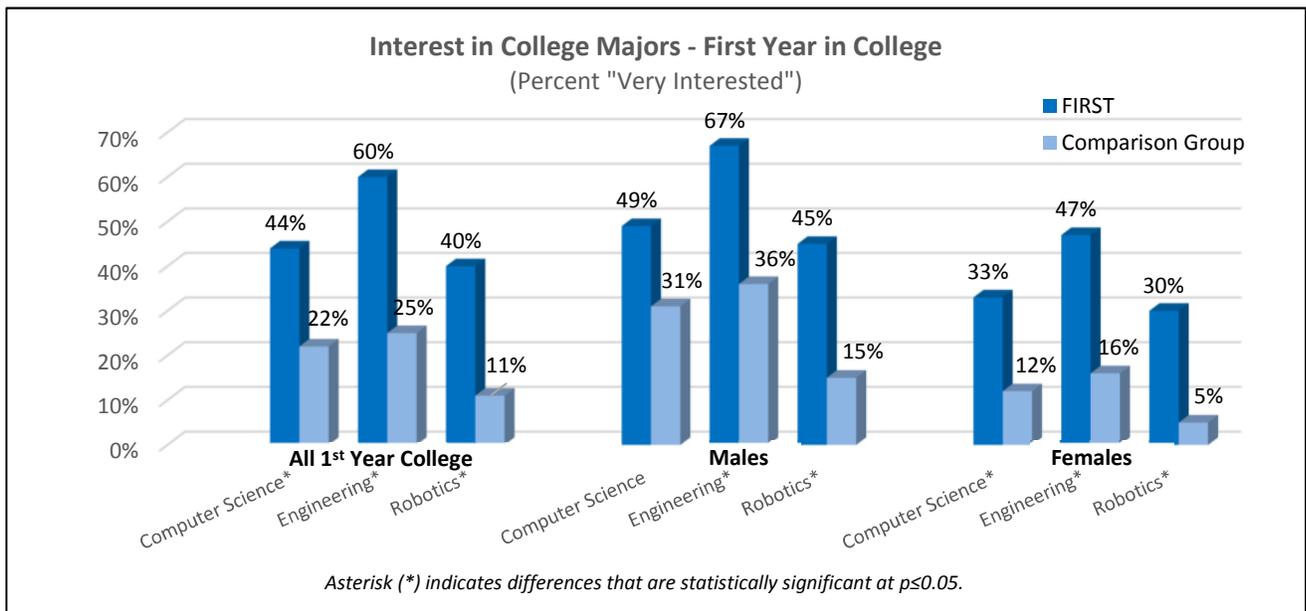


First-Year College Outcomes

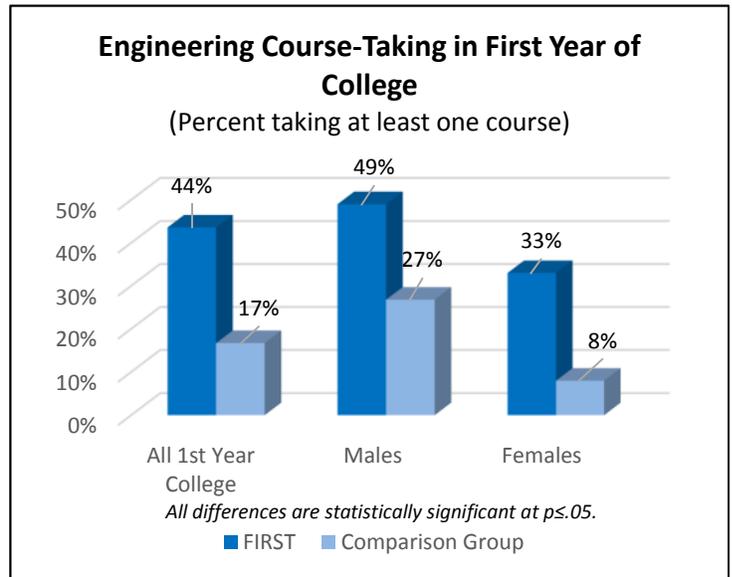
- FIRST alumni continue to show positive, statistically significant impacts on STEM-related attitudes in the first year of college.** Among first-year college students, FIRST alumni continue to show greater gains than comparison students on measures of STEM-related interest, activity, interest in careers, identity, and STEM knowledge and understanding. Both male and female alumni show significant impacts; however, female FIRST alumni continue to show significantly larger gains than males.



- FIRST alumni also report significantly stronger interest in majoring in computer science, engineering, and robotics in the first year of college than comparison students (below).** FIRST alumni are nearly twice as likely (1.8 times) to be interested in majoring in computer science, 2.3 times more likely to be interested in engineering, and 3.9 times more likely to be interested in majoring in robotics than comparison students. Each of those differences is large enough to be statistically significant. The impacts of FIRST are particularly notable among female students: female FIRST alumni are more than 3 times more likely to want to major in computer science and engineering and 5 times more likely to want to major in robotics than female comparison students. In contrast, comparison group students are significantly more likely to be interested in majoring in two non-technology STEM fields: biology and health professions.



- FIRST alumni are also more likely to take an engineering course during their first year in college than comparison students.** *FIRST* alumni were more than twice as likely (2.3x) as comparison students to take an engineering course in their freshman year; overall 44% of *FIRST* alumni reported taking engineering in their first year of college. Among women, the differences are larger: female *FIRST* alumni are 3.4 times more likely to take an engineering course than female comparison students. Thirty-three percent (33%) of female *FIRST* alumni took an engineering course compared to 8% of female comparison students.



- Female FIRST alumni were also five times more likely than women in the comparison group to take computer science courses in their first year of college.** Overall, 40% of *FIRST*'s female alumni took a computer science class in their freshman year vs. 11% of comparison women.

- Finally, FIRST alumni were also significantly more likely to be engaged in STEM-related activities during their first year at college than comparison students.** As the table below shows, *FIRST* alumni were more likely to have a

STEM-related internship, join a computer or engineering club, participate in an engineering competition, receive an engineering-related grant or scholarship. *FIRST* alumni were less likely overall to have a summer job than comparison students (perhaps because of their internships), but more likely to have a summer job that was STEM-related.

STEM Activities in the First Year at College

Activity	FIRST	Comparison
STEM-Related Internship*	19.0%	9.2%
Joined Computer Club*	16.3%	7.4%
Joined Engineering Club*	30.8%	12.3%
Participate in an Engineering Competition*	11.8%	5.6%
Received Engineering-Related Grant or Scholarship*	8.7%	3.1%
STEM-Related Summer Job*	15.6%	7.2%
Non-STEM Summer Job	40.1%	57.5%
No Summer Job	44.4%	35.3%

Asterisk (*) indicates differences that are statistically significant at $p < 0.05$.

Conclusion

Four years after entering *FIRST*, program participants continue to show consistently greater gains on STEM-related interests and attitudes than comparable students in the comparison group. Positive impacts from participation in *FIRST* are evident across all three *FIRST* programs in the study and across all of the major population groups. *FIRST*'s impacts are particularly strong for female participants who generally show significantly greater gains than those experienced by males in the program. Data on students in their first year of college shows *FIRST*'s positive impacts continue into postsecondary education, with *FIRST* alumni continuing to show impacts on STEM-related attitudes, as well as impacts on interest in technology-related majors, engineering course-taking, and STEM-related activities (internships, clubs, competitions, and summer jobs). While the study will continue to follow students to and through postsecondary education, 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.