

***FIRST* Longitudinal Study:  
Findings at 36 Month Follow-Up  
(Year 4 Report)**

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## Background

*FIRST* (For Inspiration and Recognition of Science and Technology) is a national 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 2016-17, *FIRST* reported that over 460,000 young people participated in its programs on more than 52,000 teams and competing in more than 2,600 events worldwide.<sup>2</sup>

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 21<sup>st</sup> century personal and workplace-related skills?

## KEY FINDINGS AT 36 MONTH FOLLOW-UP

- Follow-up data continue to show *FIRST* has a positive impact on participants on key STEM-related measures, including interest in STEM, involvement in STEM-related activities, STEM identity, STEM knowledge, and interest in STEM careers. *FIRST* team members are 2.3 to 3.7 times more likely to show gains on STEM-related outcomes than students in the comparison group.
- The data continue to 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.
- While all *FIRST* participants show significant impacts relative to comparison students, team members who persist in *FIRST* for more than one year show greater gains on STEM-related measures than those who only participated in *FIRST* for a single year.
- Among first-year college students, *FIRST* alumni report significantly higher interest in majoring in computer science, engineering, and robotics than comparison students and are 2.6 times more likely to take an engineering course.

<sup>1</sup> This report is based on data from the third round of follow-up surveys, which were administered approximately 36 months after students entered the study (baseline).

<sup>2</sup> <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 among young women, white and non-white youth, and youth from low-income communities? If there are differences, what can we learn about why those differences occur and how to address them 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 36 Month Follow-Up

This report presents a summary of the impact findings based on three years of data, including survey data from baseline and post-program surveys and two rounds of annual follow-up surveys. As such, it reflects the impacts of participation in *FIRST* three years after study participants entered the program. Of the 1,273 students who began the study, 1,045 students (82%) completed the 36 month follow-up survey, including 636 *FIRST* participants (77% of those at baseline) and 409 comparison students (91% of those at baseline). Of the *FIRST* participants responding to the follow-up survey, 46% (295) were still active in the program.<sup>3</sup>

**Exhibit 1: Data Collection through 36 Month Follow-Up**

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

\*The initial group of comparison students did not complete a post-program survey.

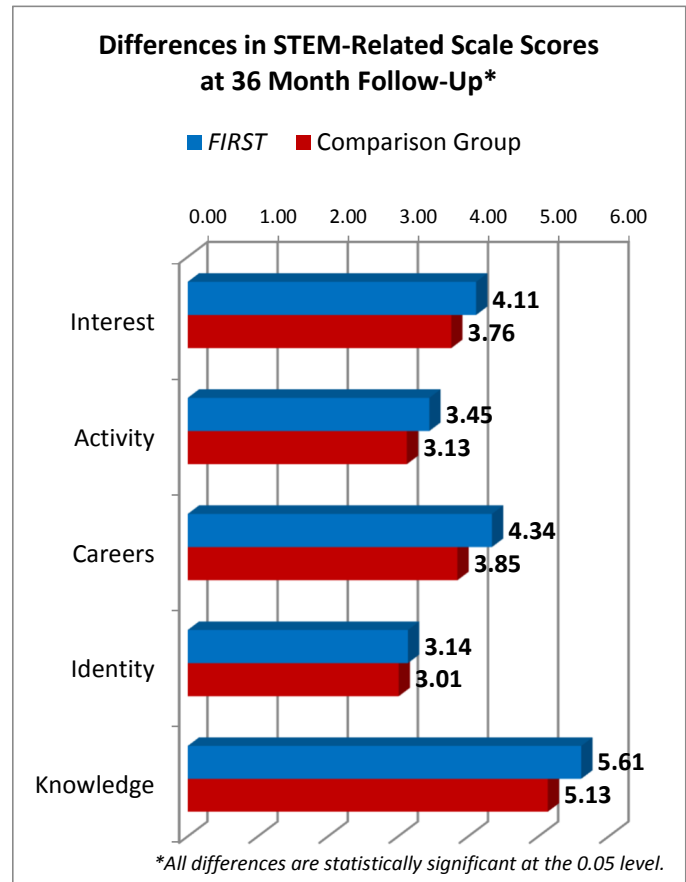
In large part, the findings from the data from the 36 month follow-up surveys confirm the impact findings from the 2015 and 2016 impact reports: *FIRST* participants continue to show *significantly greater gains* on STEM-related attitudes and interests than comparison students and are *significantly 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 major *FIRST* programs (*FIRST* LEGO League, *FIRST* Tech Challenge,

<sup>3</sup> Of the 341 *FIRST* participants no longer active in the program at the 36 month follow-up, 128 (37.5%) had graduated high school and were no longer eligible for the program; 213 (62.5%) were still in middle or high school. Overall, 58% of those eligible to participate in *FIRST* (i.e., still in middle or high school) were still active in the program.

and *FIRST* Robotics Competition), across key demographic groups, and for those living in different types of communities (urban, rural, suburban).<sup>4</sup> Data on students in their first year of college also point to positive, longer-term impacts. In their first year of college, *FIRST* alumni continue to show significantly stronger STEM-related attitudes and interests than comparison students; are more interested in majoring in key STEM-related fields (computer science, engineering, and robotics); and are more likely to take engineering courses during their freshman year. Major findings include:

***FIRST* has a continuing, positive impact on participants on all STEM-related measures, including interest in STEM, involvement in STEM-related activities, STEM identity, STEM knowledge, and interest in STEM careers. *FIRST* team members are 2.3 to 3.7 times more likely to show gains on STEM-related measures three years after entering the program than students in the comparison group.**

- ***FIRST* participants show positive, statistically significant impacts relative to members of the comparison group on all of the scale score measures of STEM-related interests and attitudes.** The average gains for *FIRST* participants on the STEM measures were significantly greater than those for comparison students (see chart to the right), including:<sup>5</sup>
  - 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).



The “effect size” for each of these measures (a standardized measure of the size or magnitude of the impacts being measured) was either “large” (the impact on STEM interest) or “medium” (the other STEM outcomes), indicating that *FIRST*’s impacts were not only statistically significant, but also large enough to represent a *practical* difference in attitudes and interests.

<sup>4</sup> 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).

<sup>5</sup> 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 three points in time (baseline, post-program, and follow-up). In this instance, the “mixed” results measure whether the average gains for *FIRST* participants were significantly greater than the gains experienced by comparison students.

- **FIRST participants were also significantly more likely to show a gain on STEM-related measures than comparison students between baseline and the 36 month follow-up.**<sup>6</sup> After adjusting for differences in baseline characteristics and baseline scale scores, *FIRST* participants were:
  - 2.9 times more likely than comparison students to show gains on *STEM interest*;
  - 3.7 times more likely to show gains in involvement in *STEM activity*;
  - 2.3 times more likely to show gains on interest in *STEM careers*;
  - 2.4 times more likely to show gains in *STEM identity*; and
  - 2.7 times more likely to show gains in *understanding of STEM*.

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

- **The data also continue to show positive 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 (Exhibit 2). The plus signs in the table (+) indicate those outcomes on which *FIRST* had a positive, statistically significant impact when compared to the students in the comparison group.

**Exhibit 2: Summary of Impacts, for All Participants and by Program**

Outcomes	All Participants	FIRST LEGO League	FIRST Tech Challenge	FIRST Robotics Competition
STEM Interest	+	+	+	+
STEM Activity	+	+	+	+
STEM Careers	+	▲	+	+
STEM Identity	+	+	+	+
STEM Knowledge	+	+	+	+

Note: Plus sign (+) indicates a positive, statistically significant impact at the .05 level. Outcomes where *FIRST* students showed greater gains than the comparison group but the differences were not statistically significant at the .05 level are marked with a triangle (▲). Impacts for *FIRST* LEGO League are based on comparison to comparison group members in grades 5-8 at baseline; *FIRST* Tech Challenge and *FIRST* Robotics Competition impacts are based on comparison to comparison group members in grades 9-12.

- **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 and non-White, and urban, suburban, and rural youth – shows significantly greater gains for *FIRST* participants than for comparison students from the same population or community type. (Exhibits 3 and 4).

<sup>6</sup> Based on “Logistic Regression” analysis (“Logit”). Logit analysis estimates the relative probability that participants and comparison students will achieve a particular outcome, taking into account differences between the groups at baseline. In this case, the Logit analysis measures whether *FIRST* participants are significantly 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). The “odds ratio” produced by the Logit analysis is a measure of that relative likelihood (for example, “2.9 times more likely to show a gain in STEM interest”).

**Exhibit 3: *FIRST* Shows Positive Impacts on STEM-Related Measures Across Major Population Groups**

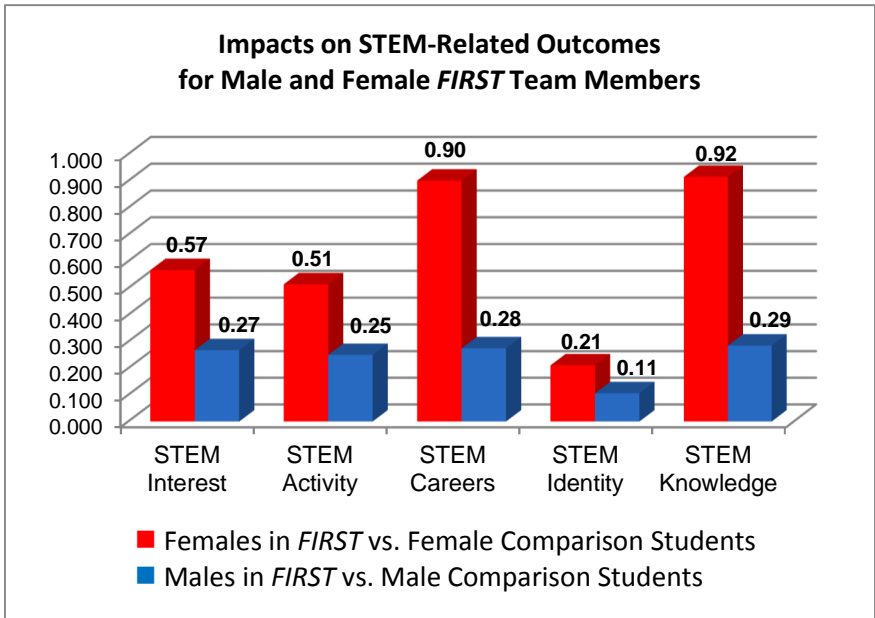
Outcomes	Males	Females	Low Income	High Income	White	Non-White
STEM Interest	+	+	+	+	+	+
STEM Activity	+	+	+	+	+	+
STEM Careers	+	+	+	+	+	+
STEM Identity	+	+	+	+	+	+
STEM Knowledge	+	+	+	+	+	▲

**Exhibit 4: *FIRST* Shows Positive Impacts on Across Different Types of Communities**

Outcomes	Urban	Suburban	Rural
STEM Interest	+	+	+
STEM Activity	+	+	+
STEM Careers	+	+	+
STEM Identity	+	+	+
STEM Knowledge	+	+	+

Notes: In Exhibits 3 and 4, the plus sign (+) indicates a positive, significant impact at the .05 level based on the “Mixed” method of analysis. Outcomes where *FIRST* students showed greater gains than the comparison group but the differences were not statistically significant at the .05 level are marked with a triangle (▲). Impacts are relative to comparable subgroups in the comparison population (for example, male *FIRST* participants compared to male comparison group members or urban *FIRST* participants compared to urban comparison group members). Low income is defined as those whose family income is below \$50,000; High Income is defined as those whose family income is \$50,000 and higher. Community type is based on information provided by parents at baseline.

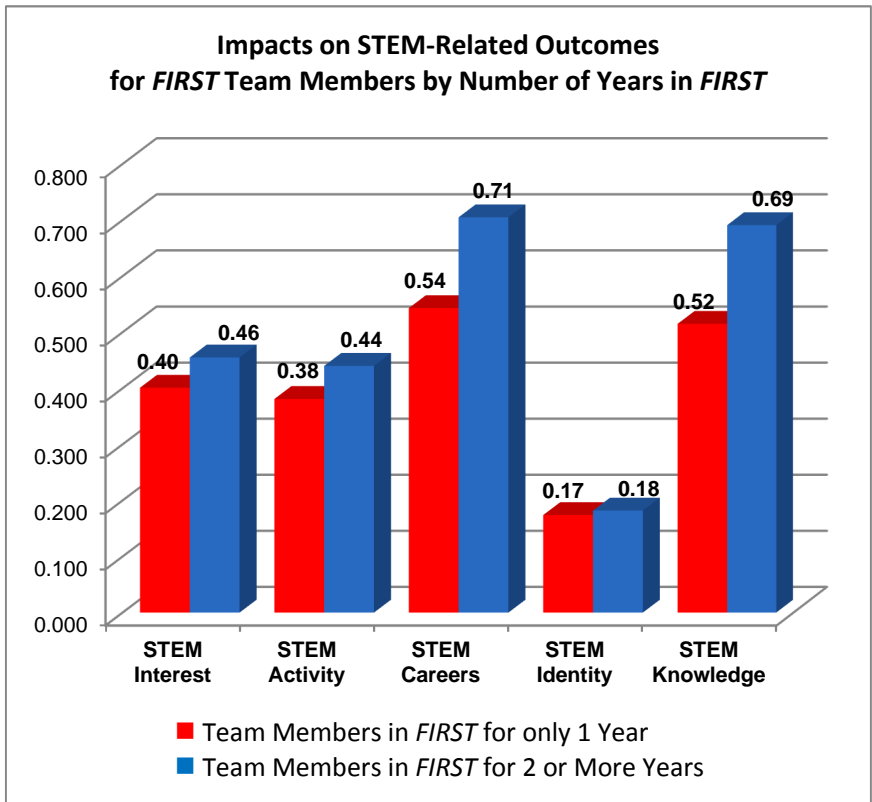
- FIRST* continues to show significantly greater impacts on girls than their male counterparts on all of the STEM-related measures.** The chart to the right shows the differences in outcomes for girls in *FIRST* compared to girls in the comparison group, and for boys in *FIRST*, compared to comparison group boys. While all of the differences between *FIRST* participants and comparison students are significant, the impacts for girls in *FIRST* on each measure are also significantly larger than those for boys.



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 the .05 level.

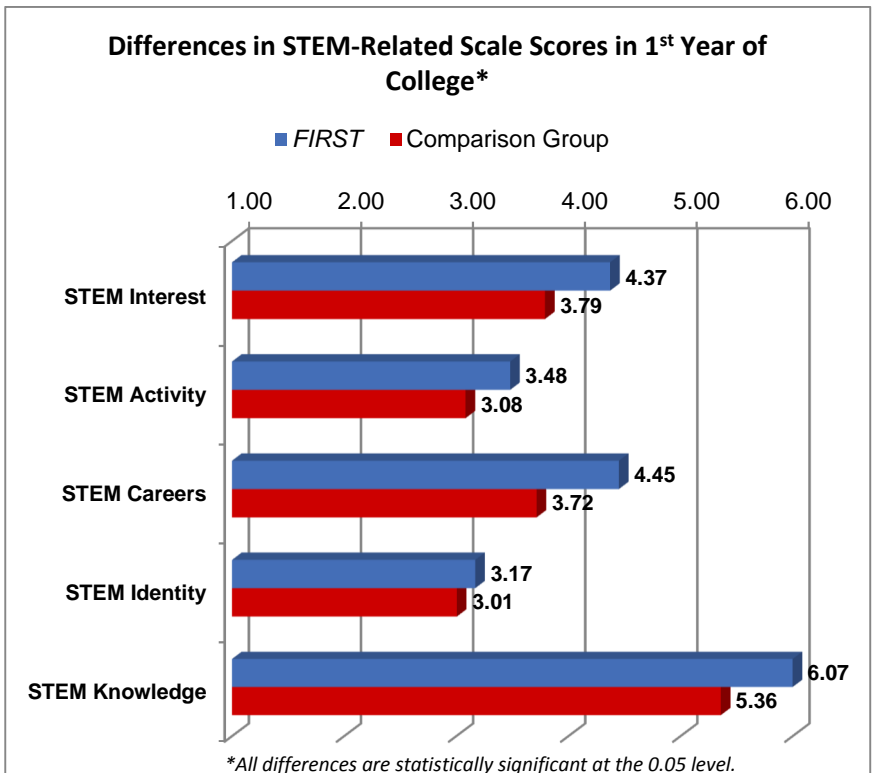
- **Impacts also vary based on time in FIRST programs.** While all FIRST participants show significant impacts relative to comparison students, team members who persist in FIRST for more than one year showed greater gains on STEM-related measures than those who only participated in FIRST for a single year.

It is important to be cautious in interpreting this result, since the students who stayed in FIRST for two years were self-selected, and may have had different interests at that point from those who left the program. However, the results do show that the program has a positive impact for those who stay only a single year and that those who persist continue to show gains.



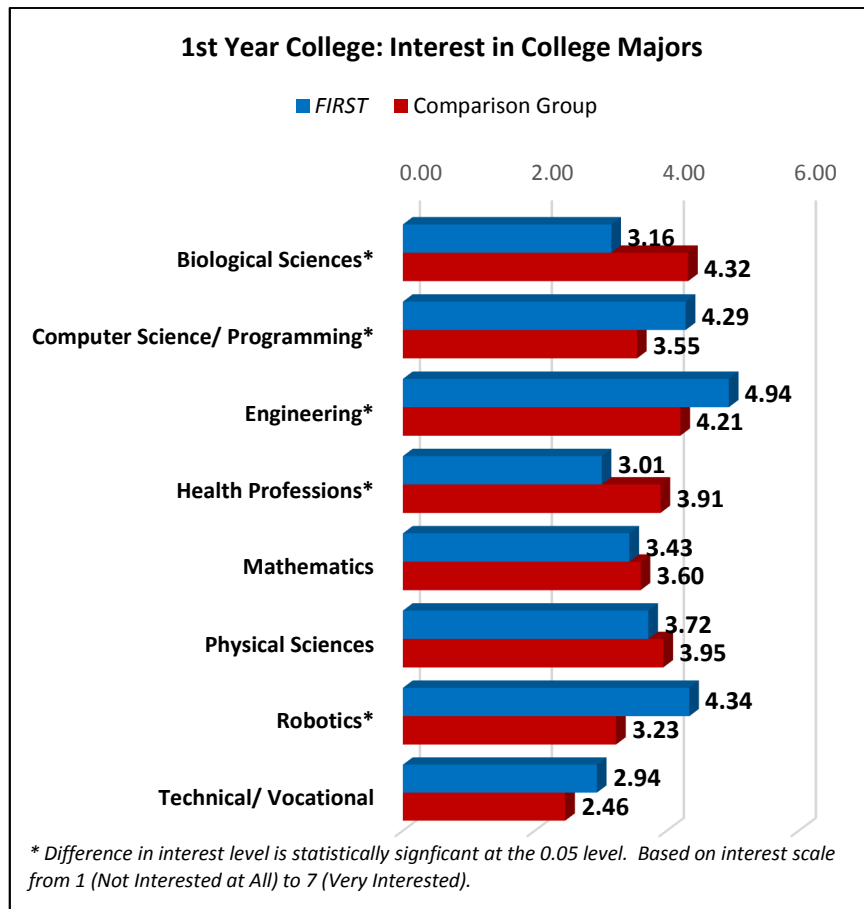
Note: Values on the chart represent the differences in outcomes (estimated scale scores) between FIRST participants and comparison students, showing separate results for FIRST participants who stayed in the program for 1 or for 2 or more years. All differences are statistically significant at the .05 level.

- **FIRST impacts continue into the first year of college:**
  - 91% of FIRST participants and 90% of comparison students in the study continued on to a 2 or 4 year college after high school.
  - FIRST alumni in their first year of college continue to show significant impacts on STEM-related attitudes relative to comparison students in the study (chart at right).
  - While both FIRST alumni and comparison students show an interest in STEM majors, FIRST alumni report a significantly higher interest in majoring in computer science, engineering, and robotics than comparison





- students. Comparison students show a significantly higher interest in biological sciences and health professions (chart at right).
- *FIRST* alumni are 2.6 times more likely to take an engineering course in their freshman year than comparison students.
  - Overall 43% of *FIRST* alumni took an engineering class in their first year of college, and 33% took a computer science class (vs. 16% and 21% of comparison students respectively).
  - Finally, while the numbers in the sample are still small, *FIRST* alumni are twice as likely to have had a STEM-related internship in their first year of college as comparison students (20% vs. 9%) and more than twice as likely to have a STEM-related summer job (16% vs. 7%).



- **The study also examined outcomes for a number of non-STEM measures related to self-concept, self-assessed life and workplace skills, and college readiness.** As in earlier years, *FIRST* participants and comparison group members continue to show comparable results. While *FIRST* participants were slightly more likely to show gains across most non-STEM measures than comparison students (based on the LOGIT analysis), the differences in outcomes were small and generally not statistically significant.<sup>7</sup>

As noted in earlier reports, the non-STEM results likely reflect the fact that both *FIRST* team members and comparison group students are engaged in a variety of activities that are designed to help build the same personal and life skills as *FIRST*. In the annual surveys, both *FIRST* team members and comparison students report gains on a variety of teamwork, problem-solving and communications skills during the past year. Focus groups with *FIRST* participants have similarly highlighted gains in those skills as well as in self-confidence and career awareness as a result of their *FIRST* experience. However, while *FIRST* participants report gains from their *FIRST* experience, over 80% of both *FIRST* participants and comparison students report being engaged in extracurricular activities (sports, performing arts, clubs, etc.). School curricula also now increasingly emphasize the development of 21<sup>st</sup> Century skills, often through project-based learning activities. Consequently, both *FIRST* team members and comparison students are

<sup>7</sup> Non-STEM measures include: academic self-concept, college readiness/support, self-efficacy, and self-assessed 21st Century skills (teamwork, problem-solving and communications skills). *FIRST* participants did show a significant impact on self-assessed communications skills in the LOGIT analysis (i.e., *FIRST* participants were more likely to show a gain on that measure than comparison students). However, there were no significant differences on any of the other non-STEM outcomes in the analysis.



increasingly involved in an array of experiences and settings that promote personal and life skills development.<sup>8</sup> In that context, the similarity in non-STEM results tends to reinforce the significance of *FIRST*'s STEM-related impacts. Among two active and engaged groups of young people, involvement in *FIRST* appears to be a critical difference-maker in promoting STEM-related interests and attitudes.

## **Conclusion**

As the *FIRST* Longitudinal Study completes its third year of data collection, *FIRST* participants continue to show consistently greater gains on STEM-related interests and attitudes than comparable students in the study's comparison group. The positive impacts from participation in *FIRST* are evident across all three of the *FIRST* programs included in the study and across all of the major population groups in the study. *FIRST*'s impacts are particularly impressive given that students in the comparison group represent a similarly motivated and academically successful group of middle school, high school and now college students. Initial data on students in their first year of college indicates that *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 engineering and technology-related majors, engineering course-taking, and STEM-related internships and summer jobs. As the study continues, we will continue to track the differences in the educational and career trajectories of *FIRST* participants compared to their peers. However, the results to date indicate that *FIRST* is already making a lasting difference in career interests and educational choices for the young people who participate in the program.

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<sup>8</sup> When asked in the follow-up survey where they had learned specific skills, including communications, collaboration, using information, problem-solving and technology skills, roughly half of the *FIRST* participants and more than 60% of comparison students listed school and school projects as the place where those skills were developed. A separate set of telephone interviews with a random sample of *FIRST* participants and comparison students provided a similar set of findings.