

***FIRST* Longitudinal Study:
Summary of Preliminary Findings – Year 2**

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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 Junior *FIRST*® LEGO® League program serving elementary school-aged youth (ages 6-9), followed by the *FIRST*® LEGO® League (FLL®) program serving primarily middle school-aged youth (ages 9-14), the *FIRST*® Tech Challenge (FTC®) serving grades 7-12, and *FIRST*® Robotics Competition (FRC®), serving high school-aged youth (grades 9-12). In 2013, *FIRST* reported that over 314,000 young people participated in its programs on more than 29,000 teams and competing in nearly 1,400 tournaments worldwide.

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 FLL, FTC, and FRC programs on program participants?** Specifically, what are the program impacts on a core set of participant outcomes that includes: 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 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?

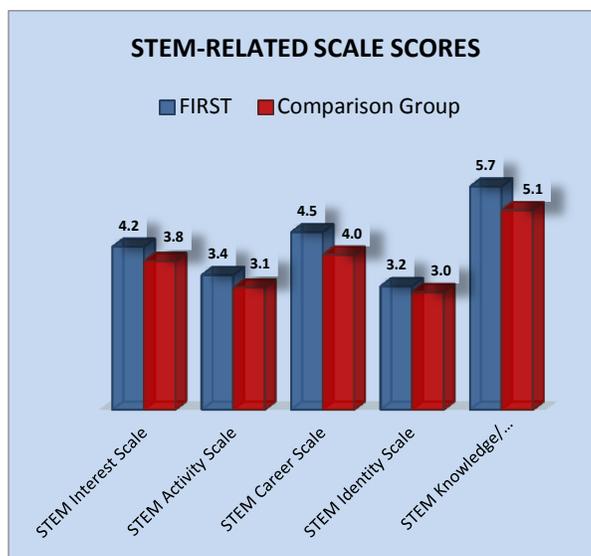
To address these questions, the Longitudinal Study is tracking approximately 1,270 students (approximately 820 *FIRST* participants and 450 comparison students) over a five year period beginning with entry of the *FIRST* participants into the program. Team members were recruited to the study from a nationally representative sample of “veteran” teams from the FLL, FTC, and FRC 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 are being surveyed at baseline and post-program in their first year, with annual follow-up surveys each spring thereafter. A baseline survey of parents has 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 provides additional contextual data on the *FIRST* teams. Team member surveys are also being supplemented by interviews and focus groups with team members at tournaments and with site visits with selected teams.

Impacts

This report presents a brief summary of the study findings based on the full two years of data collection. The full report includes findings on the characteristics of *FIRST* participants and their program experience as well as the initial impact analysis, which examines the differences in outcomes between *FIRST* participants and comparison students. This summary focuses on the findings from the impact analysis.¹ Major findings include the following:

The results of this initial impact analysis show positive, statistically significant impacts for FIRST participants as a whole and for each of the three programs (FLL, FTC and FRC) on almost all of the measures of STEM-related interests and attitudes in the study.

- *FIRST* participation has a positive, statistically significant impact relative to members of the comparison group on all of the scale score measures of STEM-related interests and attitudes (see chart to the right): *interest in STEM, involvement in STEM-related activities, interest in STEM careers, STEM identity* (for example, “I see myself as a math, science, 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”).
- *FIRST* has a positive impact on two of the three STEM-related factors – *interest in Technology* and *interest in Science* (no impact on *Math interest*).
- *FIRST* participants also showed positive impacts on two non-STEM factor measures: the *Attribution/Theory of Knowledge Factor* (belief that learning can take place through effort rather than innate ability) and the *Problem-Solving Factor* (ability to find information, solve unexpected problems, etc.).



¹ 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.

At the same time, the preliminary results show fewer significant differences between FIRST participants and comparison students on the non-STEM-related measures.

- While the data show positive impacts on two non-STEM measures (noted above), on the other non-STEM measures (including *academic self-concept*, *college support*, *self-efficacy* (belief in one’s ability to accomplish a goal) and *self-assessed 21st Century skills*) there were no significant differences: that is, the changes in attitudes and self-assessed skills for FIRST participants were *not* significantly different than those for students in the comparison group (see chart to the right).

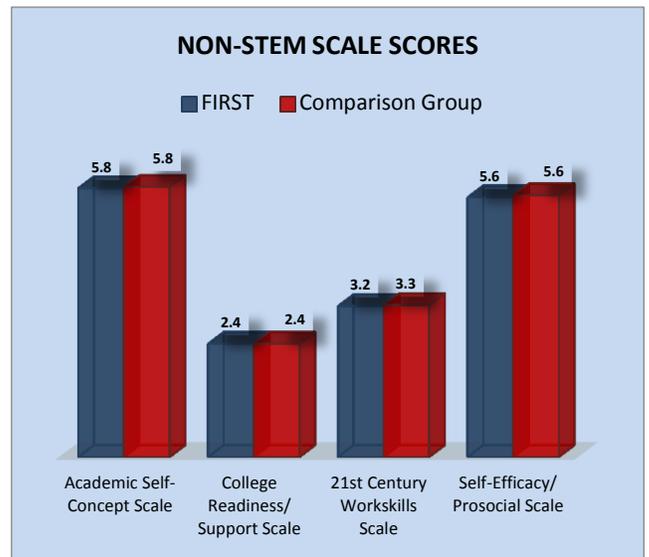


Exhibit 1 provides an overview of the impacts for FIRST participants across all programs and impacts for FIRST participants on a program by program basis. The plus signs in the table (+) indicate those outcomes on which FIRST had a positive, statistically significant impact as compared to the students in the comparison group. An empty cell indicates no significant impact.

Exhibit 1: Summary of Impacts, for All Participants and by Program

Outcomes	All Participants	FLL	FTC	FRC
<i>Scales</i>				
STEM Interest	+		+	+
STEM Activity	+	+	+	+
STEM Careers	+		+	+
STEM Identity	+	+	+	+
STEM Knowledge	+	+	+	+
<i>Factors</i>				
Technology Factor	+	+	+	+
Science Factor	+			+
Math Factor			+	
Self-Efficacy Factor			-	
Attribution/Knowledge Factor	+			
Problem-Solving Factor	+		+	

Note: Plus sign (+) indicates a positive, significant impact at the .05 level or greater. Minus sign (-) indicates a statistically significant negative impact. Empty cells indicate no significant impact for that measure/program. Impacts for FLL based on comparison to comparison group members in grades 5-8 at baseline; FTC and FRC impacts based on comparison to comparison group members in grades 9-12. Results for Academic Self-Concept, College Support, 21st Century Skills, and Self-Efficacy scales and Cooperation and Communications Factors are not significant (not shown in the table).

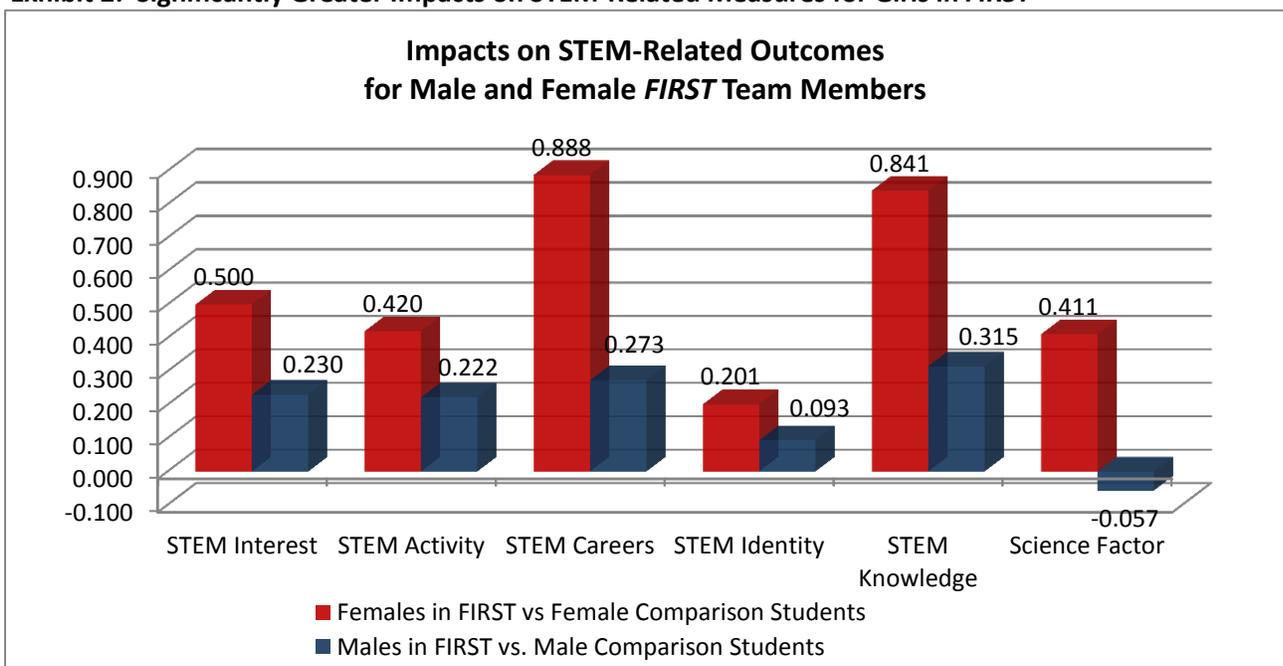
There are a number of possible explanations for the lack of measurable impacts on the non-STEM measures. Comparison group students may be engaged in other activities (in school or after) that help build the same kinds of personal and life skills, attitudes and aspirations as in *FIRST* (for example, sports, career development programs, and/or performing arts). *FIRST* participants may also assess their personal and life skills differently from comparison students as a result of the practical experience gained through working on a *FIRST* team: that is, having gained an understanding of the challenges of teamwork, leadership, and other 21st Century skills, *FIRST* team members may be more likely to underestimate the degree to which their skills have improved over a season. In some cases, positive impacts, particularly those on core attitudes like academic self-concept (the ability to learn challenging material/do well in school) or self-efficacy may only emerge over time as a result of multiple years in *FIRST* programs. As such, it is important to remember that this is early data from a longer-term study.

It is important to note that the focus group discussions with *FIRST* team members and team member responses to open-ended survey questions make it clear that team members are learning about a variety of personal and life skills such as teamwork and communications as important outcomes of their *FIRST* experience. In the end, the difference between the survey data on these outcomes and the participant testimony is an area to continue to explore.

The positive impacts on STEM-related interests and attitudes are evident across the major population groups in the study.

- That is, the positive impact of participation in *FIRST* on STEM-related outcomes is evident for both young women and men, youth from low income and higher income families, White and non-White youth.
- *FIRST* also has a similar pattern of positive impacts on youth who entered the program with lower and higher initial levels of STEM interest.
- One notable finding is that girls in *FIRST* show significantly greater impacts for all of the STEM-related scales and on the Science Factor than boys. Exhibit 2 (below) 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. The impacts for girls in *FIRST* are significantly larger than those for boys.

Exhibit 2: Significantly Greater Impacts on STEM-Related Measures for Girls in *FIRST*



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).

Exhibit 3 summarizes the impacts for *FIRST* participants by major population group (males, females, low/high income, White and Non-White). In each case, the plus sign (+) indicate those measures on which *FIRST* had a positive impact for that group of participants relative to comparable populations in the comparison group. The minus signs (-) indicate measures where the members of the comparison group scored significantly higher than *FIRST* participants.

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

Outcomes	Males	Females	Low Income	High Income	White	Non-White
Scales						
STEM Interest	+	+	+	+	+	+
STEM Activity	+	+	+	+	+	+
STEM Careers	+	+	+	+	+	+
STEM Identity	+	+	+	+	+	+
STEM Knowledge	+	+	+	+	+	
Factors						
Technology Factor	+	+	+	+	+	+
Science Factor		+	+	+	+	
Self-Efficacy Factor				-		
Attribution/Knowledge Factor				+	+	
Cooperation Factor				-	-	

Notes: Plus sign (+) indicates a positive, significant impact at the .05 level or greater. Minus sign (-) indicates a statistically significant negative impact. Empty cells indicate no significant impact for that measure/population. Impacts are relative to comparable subgroups in the comparison population (for example, male *FIRST* participants compared to male 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. Results for Academic Self-Concept, College Support, 21st Century Skills, and Self-Efficacy scales and Math, Problem-Solving and Communications Factors are not significant for any group (not shown in the table).

Finally, there are differences in outcomes among *FIRST* participants based on their level of involvement in team activities and the quality of their program experience.

- Team members who report that they were “Involved” or “Very Involved” in core team activities (reviewing rules or planning missions, designing and building the robot, programming the robot, and fundraising to support the team) showed significantly greater gains on most STEM-related measures and on several of the non-STEM measures (including 21st Century Skills and sense of self-efficacy) than team members who reported being less involved in those activities. In simple terms, those team members with a more engaged, hands-on experience were significantly more likely to show positive outcomes than team members who were less involved.
- Similarly, team members who rated their program experience highly (based on a set of questions about specific aspects of their program experience), showed significantly greater gains on almost every measure in the study. These data reinforce the importance of engaging all team members in the program’s key activities and reinforce the tenet that program quality matters.

Exhibit 4 highlights the relationship between program experience and program outcomes. For each of the core activities (Determining Mission, Reviewing Rules, etc.), the plus signs (+) indicate outcomes where *FIRST* participants who were more actively involved showed significantly greater gains than participants who were “Not Involved.” For the *Quality of Program Experience* column, the plus signs show those outcomes where *FIRST* team members who rated their experience highly showed significantly greater gains than those who reported a less highly rated experience. Again, the results highlight that higher levels of program involvement and a high quality program experience are associated with achieving positive outcomes.

Exhibit 4: Greater Program Involvement and Higher Quality Program Experiences are Associated with Significantly Greater Gains on Key Outcome Measures

	Comparing those with higher levels of involvement in each activity to those with lower levels of involvement in each activity:							
Outcomes	Deter- mining Mission/ Strategy	Reviewing compe- tion rules/ gathering information	Designing the robot	Building the robot	Program- ming the robot	Operating Robot at Tournament/ Competition	Raising money	Quality of Program Experience Scale
Scales								
STEM Interest	+	+	+		+	+	+	+
STEM Activity	+	+	+		+	+		+
STEM Careers	+	+	+	+			+	+
STEM Identity	+		+		+	+		+
STEM Knowledge	+	+	+				+	+
Academic Self- Concept	+				+	+	+	+
College Support	+	+					+	+
21 st Century Skills	+	+	+	+	+	+	+	+
Self-Efficacy/ ProSocial	+	+	+	+	+	+	+	+
Factors								
Technology Factor	+	+	+	+	+	+	+	+
Self-Efficacy Factor					+	+		+
Attribution/ Knowledge Factor								+
Cooperation Factor	+	+	+	+		+	+	+
Problem-Solving Factor	+	+	+		+	+	+	+
Communication Factor	+	+	+				+	+

Note: Plus sign (+) indicates a positive, significant impact at the .05 level or greater. Impacts are based on comparison between *FIRST* team members reporting higher and lower levels of involvement in core program activities and between *FIRST* team members who rate their program experience higher and lower on a measure of the quality of the program experience (Quality of Program Experience Scale). There were no significant differences based on program involvement or quality for the Science and Math Factors (not shown in the table).

It is important to recognize that the impact findings are preliminary, representing conclusions from Year 2 of what is expected to be a five-year or longer study. Thus far, the findings are largely consistent with the program’s expectations, with shorter term impacts on STEM-related attitudes hopefully leading to longer-term impacts on educational and career trajectories. As the study moves forward, these initial results will be updated and revised to include additional annual follow-up data, including data on longer-term outcomes such as high school course-taking, college-going, and STEM involvement (STEM majors, internships, etc.) in college. In the meantime, this report provides some critical evidence that *FIRST* is making a difference in the attitudes and interests of those students who participate in the program.