FIRST Longitudinal Study
Technical Note
April 2019

The *FIRST* Longitudinal Study was designed to provide a rigorous assessment of the short and longer-term impacts on three of *FIRST*'s major programs – the *FIRST*® LEGO® League (FLL®), the *FIRST*® Tech Challenge (FTC®), and the *FIRST*® Robotics Competition (FRC®) – on the educational and career trajectories of the programs' participants. The goal of the study is to determine whether, as a result of participation in *FIRST*, middle and high school-aged young people are more likely to gain and sustain an interest in STEM, pursue STEM-related education in high school and college, and take steps towards ultimately entering into STEM-related careers than are similar youth who do not participate in the program. Other key outcomes for the programs (and the study) include the development of a variety of attitudes and skills related to success in the 21st Century workplace, including teamwork, problem-solving and communications skills, leadership and service, and the ability to work with others (including competitors). 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, urban/rural, 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?

Overview of the Study Design
The *FIRST* Longitudinal Study was designed to address these questions and provide a rigorous assessment of *FIRST's* short and longer-term impacts by applying both a longitudinal approach, tracking participants in FLL, FTC, and FRC over a period of five or more years, and by incorporating a comparison group into the design. The quasi-experimental, comparison group design is intended to provide an answer to the question "What would have happened in the absence of *FIRST*?" by comparing the changes in attitudes and educational and career trajectories of program participants with those of youth with similar interests at baseline who do not participate in *FIRST*.

To accomplish this, the Longitudinal Study is tracking approximately 1,273 students (822 *FIRST* participants and 451 comparison students) over a five plus years beginning with entry of the *FIRST* participants into the program.[1] The study is focused on new participants in *FIRST* (i.e., those with no

[1] The study includes 206 team members from FLL teams, 248 from FTC teams and 368 team members from FRC teams. The comparison group includes 195 students in 5th-8th grades and 256 high school (9th-12th grades) students.

prior participation in the FLL, FTC, or FRC program) so that it can track team members from their point of entry into the program. Team members were recruited to the study from a nationally representative sample of over 200 "veteran" *FIRST* teams in 10 states. Comparison group students were recruited from math and science classes in the same schools and organizations where the *FIRST* teams were located. Participant recruitment took place in two waves, with recruitment of an initial group of students in Fall 2012 and recruitment of additional participants in Fall 2013 to increase the size of the overall sample for the study.

One of the key decisions in designing the study was to employ a comparison group design. In impact studies like these, the preferred evaluation design is often a randomized control trial in which participants are recruited to the program being studied and are then randomly assigned to either the program in which they participate or to a control/comparison group where they are excluded from program participation. The randomization process is intended to ensure that program participants and comparison students have similar baseline interests and characteristics and to control for any inherent bias in the sample in terms of those who normally join or not join the program. For *FIRST*, however, a randomized control model was determined to not be feasible, for several reasons. In general, local *FIRST* teams recruit as many team members as they can, so it was unlikely that there would be sufficient additional applicants for randomization. Moreover, since teams tend to accept all interested youth, it would have been viewed as unethical to actively exclude interested young people from the program or to prohibit them from joining a *FIRST* team during the extended period of the study. Consequently, the decision was made early in the design process to pursue a "quasi-experimental," comparison group design that would recruit non-participating students to serve as the comparison group for the analysis. The decision to recruit comparison students from math and science classes in the schools and organizations where *FIRST* teams were located was an effort to recruit a comparison group that would include at least some students with substantial interest in STEM, while also controlling for differences at the school or community level.[2]

Data Collection

The primary source for the study is a series of baseline, post-program, and annual follow up surveys of team members and comparison students. A baseline survey of parents provides 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 provide additional contextual data on the *FIRST* teams. Surveys have been supplemented by telephone interviews and focus groups with participants in several years of the study.

Baseline surveys were administered to program participants and comparison students as paper-based surveys when they entered the study in Fall 2012 and 2013. Follow-up surveys have been administered as an online survey in each subsequent spring. With completion of the Spring 2018 survey, the study has collected 60-month follow-up data for both waves of study participants. Response rates for both

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[2] The decisions concerning comparison group design were among the most challenging for the study. Generally, *FIRST* team members, as participants in an after-school program, self-select into the program, and it was anticipated that a substantial percentage would enter the program with a prior interest in STEM. Brandeis staff and the advisory groups for the study explored a variety of options including recruiting students from other after-school programs; having team members identify non-participating friends; and recruiting students from other, non-*FIRST* schools. Ultimately, it was decided to recruit comparison students from math and science classes at the schools where *FIRST* teams were located as the most feasible, most likely to control for school-level effects, and as the most likely to result in recruiting sufficient numbers of comparison students for the study.

participants and comparison group members have been strong with 79% of the study participants completing the 60 month follow-up survey for the study (73% of program participants and 88% of comparison group members). Exhibit 1 shows the survey response rates for the study through 60 months.

Exhibit 1: Response Rates through 48 Month Surveys

	Base-line	12 Month Follow-Up (Post-Program)		24 Month Follow-Up		36 Month Follow-Up		48 Month Follow-Up		60 Month Follow-Up	
	N	N	% of baseline	N	% of baseline	N	% of baseline	N	% of baseline	N	% of baseline
Program Participants	822	677	82.4%	665	80.9%	636	77.4%	611	74.3%	602	73.2%
Comparison Students	451	259	NA*	411	91.1%	409	90.7%	406	90.0%	397	88.0%
Total	**1273**	**936**	**73.5%**	**1076**	**84.5%**	**1045**	**82.1%**	**1017**	**79.9%**	**999**	**78.5%**

**Wave 1 comparison students did not complete a post-program survey but have participated in all subsequent follow-up surveys.*

Study Outcomes

The major focus of the study is on *FIRST*'s impacts on STEM-related interests, attitudes, and behaviors. Key outcomes, developed in collaboration with staff at *FIRST* and with the program and technical advisory groups during the planning phase of the study, include a combination of interest and attitudinal measures (for example, increased interest in STEM and STEM-related careers, sense of educational efficacy, and postsecondary aspirations); measures of self-reported life and workplace skills; and shorter and longer-term behavioral measures such as increased STEM-related course-taking, postsecondary STEM course-taking and college majors, and continued involvement in *FIRST*. Exhibit 2 provides an overview of the key outcome measures.

Exhibit 2: Key Outcome Measures

STEM-Related Interest and Attitude Scales	Personal Development and Workplace-Related Scales	Behavioral Measures
• STEM Interest (Level of interest in science, technology, engineering and mathematics) • STEM Activity (involvement in non-school STEM activities) • STEM Careers (interest in STEM-related careers, such as scientist, engineer, computer specialist, etc.) • STEM Identity (extent to which students see themselves as science, math or technology people) • STEM Knowledge/ Understanding (awareness of applications of STEM in real world, interest in learning more about STEM).	• Academic self-concept (students' sense of their educational competence/ commitment to learning) • College Support (adult support for college readiness/knowledge) • Self-Efficacy/Prosocial Values (self-confidence, sense of belonging and contribution) • 21st Century Skills (Self-assessed life and workplace skills, includes teamwork, problem-solving and communications subscales)	• STEM Course-Taking (High School) • Interest in STEM Majors in College/Declared Majors • STEM-Related College Course-taking • Involvement in College STEM-Activities (Clubs, competitions, internships, summer jobs) • STEM-related College Grants and Scholarships

In addition to the key outcome measures, the baseline surveys collected demographic information including age, gender, race/ethnicity, ESL status, and grade in school as well as information on program participation and academic background (grade point average, honors courses at baseline). Parent surveys provided information on family income and parental support for their children's involvement in STEM. As discussed below, these baseline characteristics were used in the analysis to control for differences between participants and comparison group member characteristics at baseline and to control for the influence of characteristics like race or gender on outcomes. The survey items were drawn from a mix of existing national surveys (for example, the U.S. Department of Education's National High School Longitudinal Study of 2009), questions that had been used in previous evaluation studies, and items developed specifically for this study. The surveys were piloted with students on local after school robotics teams and revised based on their feedback. A summary of the scale measures used in the study can be found at the end of this document.

Approach to Assessing Impacts

The basic method for assessing impact in this study is by comparing outcomes for participants and comparison students while controlling for differences between the two groups at baseline. As shown in Exhibit 1, the current analysis (based on 48 month data) includes data from five rounds of participant surveys, including Baseline survey data, Post-Program (end of the first year) data for most study participants, and four annual follow-up surveys (24, 36, 48, and 60 months).

To make full use of the multiple data points that are available, the study uses a "repeated measures linear mixed models" method of analysis as the primary method of statistical analysis. The "Mixed" method is a form of multivariate analysis that allows the inclusion of covariates (control variables) to control for differences in participant characteristics and settings in the analysis and for the use of repeated measures (i.e., multiple data points) over time. The mixed methods approach, unlike many other statistical tests, also allows the use of all of the data available in developing estimates of the outcomes, even when there is missing data for some students in the sample at some of the data points.[3] As a result, the mixed methods approach makes it possible to use data from all five sets of surveys despite the fact that not all students completed every one of the surveys.

The mixed methods analyses provide estimated outcome measures for team members and comparison students that take into account the various control measures and differences at baseline. When compared, the differences in those outcomes provide the measure of impact from the program – whether there are statistically significant differences in the gains (or declines) for *FIRST* team members and comparison students. For this study, adjustments for differences between the participant and comparison groups at baseline include covariates for gender, race/ethnicity, family income, participation in STEM honors courses at baseline, and baseline parental support for STEM. Analysis of behavioral measures (e.g., college major, college course-taking) also includes STEM interest at baseline as a covariate.

The study also uses a second type of multivariate analysis: Logistic Regression Analysis or "Logit." Logit analysis estimates the relative probability that *FIRST* participants and comparison students will achieve a particular outcome, taking into account differences between the groups at baseline. In this study Logit

[3] For background of the mixed models method, see A.A O'Connell and D.B. McCoach, eds. (2008). *Multilevel Modeling of Educational Data*. Charlotte, NC: Information Age Publishing; and J.D. Singer (1998). "Using SAS PROC MIXED to Fit Multi-Level Models, Hierarchical Models, and Individual Growth Models." *Journal of Educational and Behavioral Statistics*, 24(4), pp. 323-355.

analysis is used to assess whether *FIRST* participants are significantly more (or less) likely than comparison students to show an increase from baseline to follow-up on the various scale score measures (such as STEM interest); Logit is also used to examine whether *FIRST* participants are significantly more likely to want to major in engineering or take engineering courses. The "odds ratio" produced by the Logit analysis is a measure of the relatively likelihood that one group or another will achieve that particular outcome (for example, that "*FIRST* participants are 3.0 times more likely to show a gain in STEM interest" or 3.1 times more likely to want to major in engineering) after taking into account differences at baseline. As with the "Mixed" analysis, the Logit analyses in this study include covariates for gender, race/ethnicity, family income, participation in STEM honors courses at baseline, and baseline parental support for STEM and, when appropriate, STEM interest at baseline.

In sum, the two methods provide two ways of looking at program impacts. The "Mixed" analysis basically looks at the *difference in average gains* (or declines) between the two groups in the study; the Logit analysis determines whether, on average, one group or the other was significantly more likely to show *any* gain from baseline to follow-up. It is important to note that in some cases, *FIRST* participants and comparison students are equally likely to show a gain on a particular measure (no significant difference using the Logit analysis), but that on average, the gains that do take place for *FIRST* participants are significantly greater than those for comparison students (positive, statistically significant impacts using the "Mixed" analysis). Both results are accurate and appropriate – they provide two somewhat different perspectives on impact (average gain vs. likelihood of gain).[4]

Comparison Group

A critical part of the analysis of program impacts is the use of a comparison group to estimate what would have happened in the absence of the program. As noted earlier, the comparison group for the study is comprised of non-participating students (i.e., students not involved in *FIRST*) who were recruited into the study through math and science classes at the schools and organizations where the *FIRST* teams in the study are located. The goal of that effort was to recruit a comparison group that would include at least some students with substantial interest in STEM, while also controlling for differences at the school or community level. Approximately 450 students were recruited into the comparison group over the two years of recruitment for the study. Comparison group students have been told that they are participating in a study of STEM-related interests and activities (the SciTech study) and, as a result, are often referred to as "SciTech" students in the study reports.

Exhibit 3 provides an overview of the baseline characteristics of *FIRST* team members and comparison students in the study. As the table shows, the comparison group students and participants are relatively well-matched on some measures and show statistically significant differences on other. In general, the two groups are similar (i.e., no significant differences) in terms of their average age, ethnic background (percent Hispanic), the types of communities they live in, their academic performance (grades) and their educational aspirations. They also tend to come from families with similar socioeconomic backgrounds – parental education and family income. The two groups differ in the mix of middle and high school students (more *FIRST* students were in 9^{th}-12^{th} grade at baseline), the percentage of White students and

[4] The Logit analysis differs from the "Mixed" approach in one other important respect – it only makes use of data from two points in time, in this case the baseline and 1 Year Follow-up survey. Consequently, the sample sizes for the Logit analysis are substantially smaller than for the "Mixed" analysis, making it less likely for results to show statistical significance than in the "Mixed" analysis, even when differences are quite large. As a result, the study restricts the use of the Logit analysis to the analysis of impacts for the sample as a whole and the analysis of impacts by program and did not use Logit in the analysis of other subgroup differences.

youth of color (*FIRST* has a much higher percentage of Asian students; the comparison group has a substantially higher percentage of White students), the percentage of students for whom English was their first language (lower in *FIRST*), and the proportions attending different types of schools. While statistically significant (i.e., not likely to be random differences), the differences are generally not large and can be controlled for in the analysis.

Not surprisingly, there are significant differences between the groups at baseline on a number of measures of STEM interest and attitudes for both students and their parents. In terms of family environment, parents of *FIRST* participants are significantly more likely to have been employed in a STEM-related field, to consider it important that their child participate in STEM-related activities, and to encourage their child to pursue STEM interests and careers. *FIRST* participants also score significantly higher at baseline on the measures of STEM interests and attitudes used in the study. It is important to note that, while *FIRST* participants clearly enter the program (and study) with higher levels of interest in STEM, there are no significant differences on most of the baseline scale measures for the non-STEM outcomes, including academic self-concept, college support, Self-Efficacy, and self-assessed 21st Century Skills.

These differences form an important context for the study: a key goal of the analysis is to control for these baseline differences so that the participants and comparison group students are as comparable as possible. As noted above, the analysis is designed to control for these differences in two ways. First, both the mixed methods and logit approaches take baseline measures into account in calculating outcomes. In that regard, baseline differences on core outcome measures are controlled for as part of the calculation of the outcome estimates. In addition, the models used for developing the impact estimates include a number of covariates (control variables) that provide an additional adjustment for differences between participant and comparison students in the sample. As noted earlier, the final models used for the impact analyses in the study include covariates for gender, race (Asian, White, Black), socioeconomic status (income), parental support for STEM, and baseline involvement in STEM (more honors or advanced STEM-related courses at baseline and, where possible, baseline STEM interest.[5]

Summary

The *FIRST* Longitudinal Study represents an effort to address a core set of questions about the impact of participation in *FIRST* through as rigorous an analysis as possible, given the practical constraints on the overall research design. The students participating in the study are broadly representative of the range of students participating in *FIRST* programs. Comparison students were recruited with the goal of including students with similar demographic characteristics, levels of academic achievement, and interest in STEM. The measures used in the study reflect key outcomes for *FIRST*, were developed in collaboration with *FIRST* staff and advisors and draw on established assessment tools. The longitudinal data collected through the annual surveys not only makes it possible to address longer-term outcomes of program participation, but to examine patterns of participation over time. Finally, the analysis methods are designed to make effective use of the data and to control for baseline differences between participants and comparison students.

[5] Most of the direct measures of STEM interest, including the STEM interest scale, could not be used as control variables since they were included as outcomes in the analysis. Several additional variables were included in the model in the early analyses, including community type (urban/rural/ suburban), parent's education (at least one parent with a BA), and ESL status (English as a primary language). These variables were ultimately dropped from the model when it was found that they were consistently non-significant as predictors in the analysis.

Exhibit 3: Participant and Comparison Group Characteristics at Baseline

Measure	FIRST	SCITECH	ALL
Gender*			
Male	67.8%	41.5%	58.5%
Female	32.2%	58.5%	41.5%
Average Age	13.96	14.14	14.02
School Level*			
5th-8th Grade	28.5%	41.5%	33.1%
9th – 12th Grade	66.7%	56.8%	63.2%
Other	4.8%	1.8%	3.8%
Race/Ethnicity*			
Asian	17.9%	10.2%	15.2%
Black/African-American	8.5%	6.6%	7.8%
White	67.8%	82.9%	73.0%
Ethnicity (NS)			
Hispanic	16.0%	10.0%	14.5%
Other Demographic Characteristics			
ESL (English as first language)*	79.3%	85.5%	81.5%
US Born (NS)	90.3%	93.0%	91.3%
Special Education (NS)	8.1%	3.3%	7.3%
Geography (NS)			
Urban	26.0%	23.2%	25.0%
Suburban	51.3%	53.0%	51.9%
Rural	22.7%	23.9%	23.1%
School Type*			
Regular Public School	71.3%	75.1%	72.6%
Charter School	3.7%	.5%	2.6%
Magnet School	15.3%	7.3%	12.5%
Private School	7.4%	15.6%	10.3%
Academic Performance - Grades (NS)			
Mostly A's	49.5%	49.4%	49.5%
A's and B's	34.0%	36.4%	34.9%
Student's Educational Aspirations (NS)			
BA Degree or More	95.2%	96.4%	95.7%
Parent's Education (Highest Degree) (NS)			
BA Degree or More	59.4%	58.6%	59.1%
Family Income (NS)			
Under $50,000	26.9%	21.7%	25.2%
$50,000- $100,000	32.5%	34.8%	33.2%
$100,000 and over	40.5%	43.5%	41.6%
Parent Employment/Experience in STEM*			
At least 1 Parent ever employed as engineer, scientist, programmer or other STEM field.	49.3%	40.8%	46.3%

Measure	FIRST	SCITECH	ALL
Parent Support for STEM*			
Importance of having child participate in STEM activities (Important/Very Important)*	91.5%	75.4%	86.0%
Parent Encouragement of STEM (5 pt. scale)*	4.2	3.9	4.1
Parent encouragement of STEM careers (7 pt. scale)*	5.4	4.7	5.2
Participant Baseline Scale Scores	**FIRST**	**SCITECH**	
Survey Scales(average baseline scale score)			
STEM Interest*	4.1	3.7	
STEM Activity*	3.4	3.1	
STEM Careers*	4.5	3.7	
STEM Identity*	3.1	2.9	
STEM Knowledge*	5.6	4.9	
Academic Self-Concept	5.71	5.71	
College Support	2.18	2.21	
Self-Efficacy/Prosocial	5.5	5.5	
21st Century Skills	3.1	3.2	
Teamwork/Collaboration subscale	3.3	3.4	
Problem-solving subscale	3.1	3.1	
Communications subscale	2.9	3.0	

Note: An asterisk (*) indicates differences between participants and comparison group members that are statistically significant at $p \leq .05$. (NS) stands for not significant.

Survey Scale Sources

Domain	Source	Items
Interest in STEM	Brandeis University. Developed for *FIRST* Longitudinal Study (FLS) Alpha = .67	How interested are you in science, technology, engineering and/or math (STEM)? Please mark on a scale from 1 (Not interested) to 5 (Very interested). a. Science b. Technology c. Engineering d. Math
Involvement in STEM activities	Adapted from US Department of Education, High School Longitudinal Study of 2009 (Items c-f added). Alpha = .76	Other than for school, how much do you like to do the following? Please mark on a scale from 1 (Do not like at all) to 5 (Like a lot). a. Read science books and magazines? b. Visit web sites for information on computers and technology? c. Talk with friends or family about science and technology? d. Watch programs on science and technology on television (for example: Science Channel, National Geographic, Discovery Channel)? e. Design web pages? f. Take apart things (like motors, computers, toasters) to see how they work?
	Adapted from US Department of Education, High School Longitudinal Study of 2009. (Items c-f added)	Last school year [year], which of the following types of activities did you participate in through a club, camp, or a competition, in school or out of school? (Mark all that apply.) Do not include participation in *FIRST*. a. Math b. General Science (Biology, physics, chemistry, etc.) c. Robotics d. Computer/ technology e. Engineering f. Environment (clean up clubs, etc.)

Domain	Source	Items
Sense of educational efficacy	US Department of Education, Educational Longitudinal Study, 2002. Alpha = .73	We are interested in learning about how you think about yourself as a student. Using a scale from 1 (Not true at all for me) to 7 (Very true for me), please tell us how true each of the following statements are for you. a. When I sit down to learn something really hard, I can learn it. b. When studying, I try to work as hard as possible. c. If I decide not to get any bad grades, I can really do it. d. When studying, I tend to give up if the material is hard. e. If I want to learn something well, I can. f. When studying, I put forth my best effort.
College knowledge/support	Adapted from Boguslaw, Melchior, and Pierce, Partnership for College Completion: Process, Implementation and Outcome Assessment. Alpha = .82	Has any adult talked with you about the following? Please tell us whether each topic was “never discussed,” “briefly discussed,” “discussed in-depth,” or “Don’t Know.” a. How to pay for college. b. The kinds of high school courses and tests I need to take to get into college. c. The high school courses I need to take if I want to major in a STEM (science, technology, engineering, or math) field in college. d. How to apply for college. e. The kinds of scholarships that are available to help pay for college. f. Why I should go to college. g. The kinds of attitudes and skills I need in order to succeed in college.
Interest in STEM careers	Adapted from Barker, 4-H Robotics and GPS/GIS Interest Questionnaire (items e-g added). Alpha = .81	How interested are you in each of the following jobs related to STEM (science, technology, engineering, and mathematics)? Please mark one response in each row using the scale from 1 (Not interested at all) to 7 (Very interested). If you are not sure, please give us your best answer. a. Scientist b. Engineer c. Mathematician d. Computer or Technology Specialist e. STEM Educator/ Teacher f. Inventor g. Skilled technician (for example: auto or aircraft mechanic, machinist, electrician, construction)

Domain	Source	Items
Educational aspirations and expectations	US Department of Education, High School Longitudinal Study of 2009.	As things stand now, how far in school would you like to go? As things stand now, how far in school do you think you will get? a. High school diploma or GED b. Trade school/ certificate program c. Complete a two-year college (Associate's degree) d. Complete a four-year college (Bachelor's degree) e. Complete a graduate degree (MA, MBA, MSW or other Master's Degree; Ph.D., M.D., law degree, or other professional degree) f. Don't know
	US Department of Education, High School Longitudinal Study of 2009.	Whatever your plans, do you think you have the ability to complete a four-year Bachelor's degree? a. Definitely b. Probably c. Probably not d. Definitely not
STEM identity	Adapted from US Department of Education, High School Longitudinal Study of 2009 (Items i-l added) Alpha = .70	Now we are going to ask you a few questions about your beliefs about math and science. How much do you agree or disagree with the following? (Four point scale. Responses include: Strongly Disagree, Disagree, Agree, Strongly Agree) a. I see myself as a math person. b. Others see me as a math person. c. Most people can learn to be good at math. d. You have to be born with the ability to be good at math. e. I see myself as a science person. f. Others see me as a science person. g. Most people can learn to be good at science. h. You have to be born with the ability to be good at science. i. I see myself as a technology person. j. Others see me as a technology person. k. Most people can learn to be good at technology. l. You have to be born with the ability to be good at technology.

Domain	Source	Items
Understanding of STEM	Center for Youth and Communities, Brandeis University, adapted from prior *FIRST* evaluation studies. Alpha = .94	We are interested in learning about how you think about yourself and your future. Using a scale from 1 (Not True at All for Me) to 7 (Very True For Me), please tell us how true each of the following statements are for you. a. I want to learn more about science and technology. b. I can use math and science to do something interesting. c. I have a good idea of what I want to study in college or technical school. d. I am interested in having a job or career that uses science and technology. e. I understand different ways that science and technology can be used to solve problems in the real world. f. I have a good understanding of how engineers work to solve problems. g. I know about a variety of jobs and careers in STEM (science, technology, engineering and/or mathematics). h. I have the kinds of skills that are needed to be a scientist or engineer. i. I can make a good living as a scientist or an engineer. j. I would enjoy working as a scientist or an engineer. k. I can use math and science to make a difference in the world.

Domain	Source	Items
Self-Assessed life/ workplace skills	Center for Youth and Communities, Brandeis University. Adapted from prior *FIRST* evaluation studies Alpha = .87.	We are interested in learning about some of the skills you have learned through school and other activities. Please tell us how well you think you can do each of the following tasks: Not at all, A little, Pretty well, or Very well. a. Work as part of a team on a project? b. Solve disagreements between team members? c. Get along with other students, co-workers, teachers and supervisors? d. Work well with both males and females on a team? e. Find information about a problem in your school or community and any possible solutions? f. Develop a plan that identifies the steps you need to follow to get something done? g. Solve unexpected problems or find new or better ways to do things? h. Manage your time so that you can get all the steps in a job done? i. Use trial and error to figure out if something is going to work or not? j. Use math to help solve a problem in the real world (not just in class)? k. Make a presentation? l. Talk to adults you don't know about something you think is important? m. Write something (a brochure, letter, or paper, for example) that explains a project to someone you don't know? n. Work cooperatively with people that you do not know well?
Personal Development (Confidence, competence, etc.)	Foutz et al, "A Youth- Directed Science Café: Impacts on Teen Participants." (NSF Grant ISE-0714762). Alpha = .76	How true are the following for you? Using a scale from 1 (Not True at All for Me) to 7 (Very True For Me), please tell us how true each of the following statements are for you. a. When working on a team, I am willing to take on leadership roles. b. I am not confident speaking in front of a large group. c. I respect people's ideas that are different from mine. d. I like to volunteer in my community. e. My actions can change the world around me. f. I feel confident sharing with others what I know about using science and technology to solve problems. g. I am not a self-confident person. h. I have a positive future ahead of me. i. I feel like I am part of a group of people who are like me. j. In my school or community, there is an adult who believes I will be a success.

Domain	Source	Items
Quality of Program Experience	Center for Youth and Communities, Brandeis University. Adapted from prior *FIRST* evaluation studies. Based on elements of effective youth program in Eccles and Grootman, Eds (2002) Alpha = .814	How well do the following statements describe your experience on your FIRST Robotics team this year? For each statement, please tell us whether you strongly agree, agree, disagree or strongly disagree. a. Students on my team made the important decisions, not the adults. b. I had a chance to do lots of different jobs on my team. c. I had important responsibilities on my team. d. I had a chance to play a leadership role on my team. e. My team learned how to work well together. f. My team really listened to my ideas. g. The adults on my team did most of the difficult jobs in building the robot. h. I had a chance to get to know at least one of the adults on my team very well. i. I felt like I learned a lot from the adults on my team. j. I had a chance to learn about careers in science and engineering on my team. k. I learned about the FIRST college scholarships available to FTC/FRC team members. l. I learned about the importance of Gracious Professionalism. m. I had fun working on my FIRST team. n. I felt like I really belonged on my team. o. I almost always felt that my team had a good chance to win something at the FIRST competition. p. I felt I was an important part of my team. q. The adults on my team helped me think about college and careers

Note: All alpha scores with the exception of the Quality of Program Experience Scale based on Wave 1 and Wave 2 baseline survey data, N=1270. Alpha for Quality of Program Experience calculated based on Wave 1 post-program survey, N=386.