More than Robots:
An Evaluation of the FIRST Robotics Competition Participant and Institutional Impacts

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CHAPTER ONE
INTRODUCTION AND KEY FINDINGS

> *A reminder, the FIRST competition is more than robots. It's about people, it's about learning to work together, it's working together toward a shared goal, doing teamwork, it's about finding and using each individual's unique talent to make the project team greater than the sum of its parts. It's about applying skills that will lead to success in whatever you do in life.*
>
> John Abele, Chairman of the Board, FIRST

INTRODUCTION

The FIRST Robotics Competition (FRC) is a high school robotics program designed to build not only science and technology skills and interests, but also self-confidence, leadership, and life skills among high school-aged youth. The FIRST Robotics Competition challenges teams of students and their mentors to solve a common problem in a six-week timeframe using a standard "kit of parts" and a common set of rules. Teams build robots from the parts and enter them in a series of competitions that involve not only the operation of the robots, but also presentation of a variety of other associated team activities, including computer animations, activities to increase the appreciation of science and technology throughout the school and community, and involvement in community service activities. The goals of the program include an increased awareness and interest in science and technology, increased college going and potentially a focus on science and engineering careers, and the development of a set of attitudes and skills described by the program as "gracious professionalism" – the ability to work together within a team and to work cooperatively with those on other teams, including potential competitors.

In late 2002, FIRST contracted with Brandeis University to conduct an evaluation of the FIRST Robotics Competition. The goal of the evaluation was to begin to address three basic questions:

- ***What is the impact of the FIRST Robotics Competition on program participants in terms of academic and career trajectories?*** Are FIRST participants more likely to graduate high school, go to college, and take courses or pursue a career in science and technology than similar, non-participating students? What impact does FIRST have on low income, women, and minority students who are often under-represented in science and technology programs and careers?

- ***What can we learn about the implementation of FIRST in schools, both in terms of better understanding program impact and identifying "best practices"?*** How do sites vary in ways they organize their teams and the experience they provide participating students? Are some practices and/or experiences particularly important in determining impact? Are there

'best practice' lessons that can be identified that can help to guide and strengthen new teams as they join the program?

- ***What kinds of impact has participation in FIRST had on participating schools and partnering organizations?*** Has participation in FIRST helped to improve the climate of participating schools, strengthen math or science teaching, or led to broader partnerships with local companies and higher education institutions? Has participation in the program had an impact on program sponsors and the community, in terms of increased involvement in the schools, creation of new opportunities for youth, and/or changed attitudes towards students and schools?

Another key goal of the study was to focus the evaluation on schools in urban communities and/or serving high proportions of low income and minority students. One of the goals of FIRST has been to expand the involvement of low income and minority youth in FRC, and the evaluation was seen as an opportunity to explore the impacts of the program on those groups in particular.

To address these questions, Brandeis conducted a two-part study. First, in order to assess the longer-term impacts on program participants, Brandeis conducted a retrospective survey of program participants who graduated from the program between 1999 and 2003, largely focused on students from teams in schools from two metropolitan areas: New York City and the Detroit/Pontiac metropolitan area.[1] The schools/teams were selected to ensure the inclusion of schools serving low income, urban or minority students. The surveys were designed to gather information on post-high school education and career experiences of program participants, as well as data on the participants' own retrospective assessments of their program experience and the impact of the program on them. In order to provide a comparison with youth who had not been in FIRST, the study was designed to allow the comparison of FRC survey data with comparable data from an existing national dataset: the Beginning Postsecondary Student (BPS) Survey, a national sample of college-going students available through the U.S. Department of Education. [2]

Second, in order to provide feedback on program implementation and institutional impacts, the evaluation also conducted site visits and interviews with team representatives in 10 participating high schools in the two communities. Those visits were designed to gather information on the implementation of the program and impacts on participating schools and program sponsors.

The purpose of this report is to convey the final results from both the retrospective survey and site visits. The report is organized into six major sections. This initial chapter provides a

[1] The initial program design called for inclusion of schools from a third area: the San Jose/San Francisco metropolitan area. Because of difficulties in obtaining participant data from those teams, only one California team ended up in the study. Also, because several of the schools that were included in the study had contact information for participants several years prior to 1999, those earlier participants were also included in the study.

[2] The Beginning Postsecondary Students Study provides data on approximately 12,000 students who entered college during the 1995-96 school year and were tracked over a six-year period (through 2001). For background on the BPS study, see National Center for Educational Statistics, Beginning Postsecondary Students Longitudinal Study: 1996-2001 (BPS: 1996/2001), Methodology Report (Washington, D.C.: U.S. Department of Education, National Center for Educational Statistics, Technical Report (NCES 2002-171), 2002.

summary of key findings and an overview of the methodology used in the study. Chapter Two discusses the characteristics of the FRC participants and schools involved in the study. Chapter Three presents the participants' assessments of their FIRST experience, based on the FRC survey data. Chapter Four examines key education, career and developmental outcomes, also based on the survey data and data from the matched comparison group. Finally, Chapter Five reviews the site visit and interview findings, including discussions of institutional impacts, assessments of the mentor experience, and discussions of challenges and lessons learned. Chapter Six provides final conclusions for the study.

KEY FINDINGS

Key findings from the study include the following:

Program Participants

- The FIRST alumni in the study represent a diverse group, including substantial numbers of students who are minorities, women, and from families with a limited educational background. Fifty-five percent of the respondents were non-white (African-American, Asian, Hispanic, and multi-racial); 41% were female; and 37% came from families where neither parent had attended college (including community college).

- At the same time, participants were relatively successful students in high school. The mean high school Grade Point Average for alumni in the sample was 3.5 (B+) and 84% had a B average or above. Average SAT and ACT scores and participation in high school math and science classes among respondents were both above the national averages. What is not clear (and cannot be answered in this study) is whether this strong performance in high school was the result of involvement in FRC, or whether FRC attracted strong students, or both.

Team Members' Assessments of FIRST

Based on the survey responses, FIRST provided a positive experience that gave participants an opportunity to be involved in a challenging team activity, build relationships, learn new skills, and gain a new understanding of and interest in science and technology.

- Almost all participants felt FIRST had provided them with the kinds of challenging experiences and positive relationships considered essential for positive youth development.

  - Eighty-nine percent indicated they had "real responsibilities;" 76% felt they had a chance to play a leadership role; and 74% reported that students made the important decisions. Ninety-six percent reported having fun.
  - Ninety-five percent reported getting to know an adult very well, and 91% felt they learned a lot from the adults on the team. Ninety-one percent felt they "really belonged" on the team.

- Most participants also reported a positive impact on their attitudes towards teamwork, interest in science and technology, and how they saw themselves. Participants reported:

- An increased understanding of the value of teamwork (95%) and the role of "gracious professionalism" (83%).
- An increased understanding of the role of science and technology in everyday life (89%), increased interest in science and technology generally (86%), and increased interest in science and technology careers (69%).
- Increased self-confidence (89%) and an increased motivation to do well in school (70%).

- FIRST also helped increase participants' interest in serving others: 65% of respondents reported that, as a result of FIRST, they wanted to help younger students learn about math and science; 52% reported that they had become more active in their community.

- The large majority of participants also reported that FIRST had helped them gain communications, interpersonal, and problem-solving skills, and how to apply academic skills in real-world settings.

  - More than 90% reported learning important communications skills, such as how to listen and respond to other people's suggestions (94%) and how to talk with people to get information (94%). Seventy-three percent reported learning how to make a presentation in front of people they did not know.

  - Students also learned teamwork and interpersonal skills. Ninety-two percent reported learning how to get along with other students, co-workers, teachers and supervisors; 90% learned to work within the rules of a new organization or team; 88% reported learning new ways of thinking and acting from others; and 73% learned ways to stop or decrease conflicts between people.

  - Students learned problem-solving and time management skills: how to solve unexpected problems (93%); how to manage their time under pressure (90%); how to weigh issues and options before making decisions (94%); and how to gather and analyze information (88%).

  - Students also learned to apply traditional academic skills in real-world setting: 68% reported learning how to use computers to retrieve and analyze data, and 67% reported learning about using practical math skills such as using graphs and tables or estimating costs.

- Overall satisfaction with the program was high. Ninety-five percent of the alumni rated their experience as "good" or "excellent" (27% and 68% respectively). Forty-six percent of respondents indicated that FIRST had been "much more influential" than their other activities during high school.

- Finally, response to open-ended questions on the survey tended to reinforce these findings: participants cited the team experience as particularly influential and cited team skills, new relationships, an increased focus on science and engineering, and increased self-confidence and motivation, among others, as long-term impacts from the program.

Education, Career and Developmental Outcomes

While participant assessments provide one measure of FIRST's impact, the ultimate measures of FIRST's effectiveness are the degree to which alumni go on to have productive educational experiences, careers, and lives in their communities. The analysis of the alumni survey data indicate that FIRST alumni are making a successful transition to college, and are much more likely to pursue their interests in science and technology and become involved in their communities than is the case for college-going students generally or for the matched group of comparison students.

- The large majority of FIRST alumni graduated high school and went to college at a higher rate than high school graduates nationally.
  - Among those responding to the survey, 99% reported graduating high school and 89% went on to college. At the time of survey, 79% were still in college; most of the others were employed. (Only 5.5% of the alumni reported that they were unemployed.) These figures compare favorably to the national average where (based on U.S. Census data) 65% of recent high school graduates went to college.
  - The high levels of college-going applied across the board to both men and women and across racial and ethnic groups in FIRST. Seventy-seven percent of female FRC alumni were in college, 68% of African-American alumni, and 78% of Hispanic alumni – all above the national averages for those groups.
- Once in college, a substantial proportion of FIRST alumni took courses and participated in jobs and internships related to science, math and technology.
  - Eighty-seven percent took at least one math course and 78% took at least one science course in college. Perhaps more striking, 51% took at least one engineering course.
  - Nearly 60% of FIRST alumni had at least one science or technology-related work experience (internship, apprenticeship, part-time or summer job). Thirteen percent received grants or scholarships related to science or engineering; and 66% reported receiving any kind of grant or scholarship.
  - High proportions of women and minorities also participated in math/science/technology courses and internships. Forty percent of female alumni took engineering classes, 59% had a science/technology internship or job. Forty-six percent of African-American alumni and 53% of Hispanic alumni took engineering courses. Sixty-four percent of African-American alumni (but only 29% of Hispanic alumni) had science/technology internships or jobs.
- FIRST alumni were also substantially more likely to major in Engineering than the average college student nationally.
  - Of those FIRST alumni reporting a college major, 41% reported they had selected Engineering. Based on national data from the U.S. Department of Education's Beginning

Postsecondary Student study, FIRST alumni were nearly *seven* times as likely to become Engineering majors as the average college student nationally (41% for FRC alumni vs. a national average of 6%). FIRST alumni were also twice as likely to enroll as Computer Science majors (11% vs. 5% nationally).

- Women and minority alumni also majored in Engineering at comparatively high rates. Thirty-three percent of the female FRC alumni, 27% of the African-American alumni, and 47% of the Hispanic alumni reported majoring in Engineering (compared to national averages of 2%, 5% and 6% respectively).

- Finally, FIRST alumni were also substantially more likely to aspire to higher levels of education than the average college student nationally. Seventy-eight percent of FIRST alumni reported expecting to attain a post-graduate degree, either a Master's degree (47%) or another terminal degree such as a Ph.D., MD, or MBA (32%). Only 2 participants in the study (1.4%) reported that they did not expect to attain any kind of degree. Nationally, 60% of students in the Department of Education's BPS study aspired to completing a Masters degree or higher and 4.4% did not expect to receive any degrees.

The positive education and career outcomes for FIRST participants were also evident in an analysis that compared FIRST participants with a matched comparison group of students drawn from the national Beginning Postsecondary Student survey data. As noted, the comparison students were matched with FRC alumni in terms of their demographic characteristics and their high school academic backgrounds, including similar levels of high school math and science course-taking. Major findings from that comparison group analysis reinforce the positive outcomes associated with participation in FRC. FIRST alumni were:

- Significantly more likely to attend college on a full-time basis than comparison students (88% vs. 53%);
- Nearly two times as likely to major in a science or engineering field (55% vs. 28%) and more than three times as likely to have majored specifically in engineering (41% vs. 13%);
- Roughly 10 times as likely to have had an apprenticeship, internship, or co-op job in their freshman year (27% vs. 2.7%); and
- Significantly more likely to expect to achieve a postgraduate degree (Master's degree or higher: 77% vs. 69%).
- More than twice as likely to expect to pursue a science or technology career (45% vs. 20%) and nearly four times as likely to expect to pursue a career specifically in engineering (31% vs. 8%).

In each case, these differences were statistically significant. The differences in engineering majors and careers also applied to female and non-white FIRST participants, who were significantly more likely to declare engineering majors or expect to enter an engineering career than students in the comparison group.

FIRST alumni were also significantly more likely to be involved in community service and to express a commitment to several positive goals and values than the members of the matched comparison group. FRC alumni were more than twice as likely to perform some type of volunteer service in the past year as were students in the matched comparison group (71% vs. 30%), and were significantly more likely to provide some of the specific types of service that might be associated with FIRST team efforts: tutoring, coaching or mentoring with young people (such as helping another team or a younger team), fundraising, and neighborhood improvement. In each of those specific categories of service, FRC alumni reported levels of volunteer service that were four to ten times as high as those of the comparison students.

Finally, the only outcomes in which the data indicate that FRC students did significantly worse than the comparison students were in receipt of grants and scholarships in their freshman year and across all four years of college. This is a somewhat surprising result given FIRST's active efforts to raise scholarship monies for FRC participants and the fact that 66% of FRC participants reported some form of grant or scholarship in college. However, it suggests that, as of the time these FRC students were going on to college (1999-2003), those efforts had not yet resulted in a relative advantage for FRC participants in grant or scholarship funding when compared to students with similar backgrounds.

In sum, the data from the FRC survey shows FIRST as having a strong, positive impact on participating youth, including women and minorities. FIRST alumni appear more likely to go to college and to continue to pursue their interests in science and technology, with a striking proportion pursuing studies in Engineering. Young people in the program also report positive impacts on understanding of science, attitudes towards themselves and others, and a variety of work-related skills. In short, based on the data from this study, FIRST appears to be meeting its goals of providing a positive and engaging developmental experience for young people and is succeeding in its efforts to increase the interest and involvement of participating youth in science and technology.

Institutional Contexts: Impacts on Schools, Teachers, and Mentors

- Based on data gathered through site visit interviews and observations, FIRST has also had a positive impact on participating schools and teachers, though that impact was limited in scope.
  - Involvement in FIRST has led to creation of new courses and/or integration of robotics instruction into existing classes in 8 of the 10 schools visited. FIRST has also helped teachers to develop or exercise new skills (primarily planning and management skills) and has had a positive effect on school spirit in a number of schools (one team leader attributed an increase in school enrollment to FRC's impact on school reputation).
  - At the same time, involvement in FRC has not led to broader changes in teaching or curriculum, or to the establishment of broader partnerships with FRC sponsors. In most cases, this was not seen as a goal for the program.
- Mentors played an important role in almost all of the teams visited, with the specific roles varying widely.

- Most teams reported mentors provided assistance through a combination of topic-based technical workshops for team members and hands-on guidance with individual students. In some cases, mentors also helped students with homework and worked to develop positive relationships with students on the teams. None of the mentors reported receiving any training in preparation for their role, though only two felt that it was needed.

- Some sponsors took additional steps, including working with multiple teams, establishing workshops for teams in a region, allowing multiple teams to use workshop space, and in some cases branching out to start new or work with new teams.

- At least 3 of the 10 teams in the study also had FIRST alumni working as mentors.

- Mentors generally reported positive impacts, including opportunities for career advancement, increased morale and job satisfaction, access to new hires, and a sense of satisfaction and connection to students on the team.

- In general, company-wide impacts on the sponsoring companies were limited. While some firms did include their involvement in FIRST in promotional materials, most did not. Similarly, while individuals within firms recruited interns from among FIRST participants, most recruiting and hiring of FRC participants took place on an ad hoc basis rather than through consistent company policy.

- Site visit interviews also identified a number of barriers and challenges faced by the teams. Some of those challenges include the following:

  - Start-up challenges: learning how to organize and run the team.

  - Meeting space: access to space and equipment to build the robot.

  - Transportation and safety: transporting students to and from team meetings, particularly during competition season when the team might work until late at night.

  - Financial challenges: obtaining and maintaining sources of funding was overwhelmingly reported to be the primary challenge in doing FRC, with travel (to tournaments) as the biggest cost.

  - Burnout: most coaches noted burnout as a danger and suggested strategies that included dividing the workload among several coaches and "over-organizing" to ensure smooth team operations.

  - Working with sponsoring corporations: several teams reported challenges working with sponsoring companies, including limited team control over the budget and pressure on the mentors to win from the company CEO.

  - Recruiting mentors: experiences varied widely, with Michigan teams generally reporting greater corporate support (most had been approached by companies) and those in NYC

reporting greater challenges in securing the interest of sponsors and mentors.

- Recruiting teachers: another ongoing challenge, but an important step for teams to take in order to share the workload. In some cases recruitment was difficult because non-FRC teachers were resentful of the attention received by those already involved in FRC or saw the FRC team as "owned" by a particular teacher.

- School administrative and district support: support varied, from strong administrative support and access to resources, to more reluctant support. Similarly, district support ranged from little or none (because of budget cuts) to active support (funding for travel, etc.). One key is making the benefits of participation clear.

- Parent support: most teams indicated they have only low levels of parent volunteer support.

- Several additional challenges were also identified by the mentors who were interviewed as particularly important in working with underserved schools. Those included:

  - Turnover of school administrators: high levels of turnover at urban schools required that administrator 'buy-in' be renewed on a regular basis.

  - Attendance of team members at meetings: the need of some team members to balance team participation with after-school responsibilities, including work and child care for siblings, made consistent involvement difficult for students on some teams. Transportation to and from meetings also presented a problem for some team members.

  - Addressing the needs of students from underserved areas: while positive about their experiences, some mentors did note the additional challenges involved in working with students, i.e., difficult personal lives or limited experiences and social skills.

  - Working with school staff: gaining consistent teacher participation, challenges in communicating with teachers, and differences in operating philosophies.

Recommendations

The principal findings of this study provide strong support for the continued growth and expansion of the FIRST robotics programs, particular into communities serving low income and minority youth. The major recommendations are to continue to document the effectiveness of the program and to build a broader base of evidence for the program's impacts through two mechanisms: a larger-scale longitudinal study that would allow for a more comprehensive analysis of participant impacts, and the development of a participant registration process for FRC that would make it easier to keep in touch with FIRST alumni and to track the longer-term career trajectories of former participants.

METHODOLOGY

As noted above, the evaluation of the FIRST Robotics Competition is based on two major sources of data: a retrospective survey of FRC participants and site visits and interviews in a number of FRC sites. In both cases, the goal of the study was to provide multiple perspectives on the FIRST experience and to be able to address a wide range of potential impacts on program participants, participating institutions, and program partners.

FRC Retrospective Survey. The primary source of data on participant impacts is a survey of former FRC program participants from schools largely in the Detroit/Pontiac and New York City metropolitan areas. Initially, thirty schools/teams were invited to participate in the study. One of the major challenges for the study was the absence of program records and useable contact information for many of the sites originally included in the sample. As a result, construction of a sufficient sample took considerably longer than originally anticipated and a number of schools/teams were never able to provide information on former team members. Ultimately, fourteen teams were able to provide identifying information on approximately 360 former FIRST participants.

Survey Administration. Surveys were then distributed by mail and email beginning in April 2004. Respondents were offered the option of completing the surveys online in a web-based version, by returning a paper version in a postage paid envelope, or through a telephone interview. Participants were also offered an incentive payment of $20 for completion of the survey. Evaluation staff conducted multiple rounds of outreach and follow-up activities to encourage a response, including email messages, reminder postcards, letters to parents, and telephone reminders to those students where a phone number was available. Where mailed materials were returned as undeliverable, an effort was made to update the contact information through program staff, college directories, and online telephone directories. Altogether, completed surveys were received from 173 former participants, an overall response rate of 48%. When those participants for whom a valid address or telephone number could not be found are excluded from the count (61 participants), the final response rate increases to 57%.

Survey Content. As noted above, the surveys were designed to gather information on participants' post-high school education and employment experiences, as well as information on their involvement in the FIRST Robotics Competition and their retrospective assessment of the impact of the program. Major elements of the survey included the following:

- Graduation from high school
- College attendance
- College courses and majors
- Internships, scholarships, and part-time or summer jobs
- Post-high school employment
- Involvement in community service
- Involvement in FIRST activities
- Self-reported FIRST impacts

The surveys also collected data on each student's high school academic background and demographic characteristics. Those data were designed to provide a profile of the young people in the sample to allow for examination of differences by key demographic characteristics (for example, race/ethnicity or gender). The demographic data and the high school academic data, however, were also intended to be used to develop a matched comparison group sample drawn from the U.S. Department of Education's Beginning Postsecondary Student (BPS) Survey.

Matched Comparison Group. One of the key elements of the study design was the use of a matched comparison group drawn from an existing national dataset in order to compare selected outcomes for FIRST participants to those of young people with similar demographic characteristics and high school academic backgrounds. The goal of the comparison group process (known as a "quasi-experimental" design) is to be able to distinguish the outcomes that were a result of participation in the program from those that would have occurred if students had not been in FIRST. This is accomplished by comparing the experience of FIRST participants to similar, non-participating young people. Generally, a comparison group is formed by identifying a similar group of students at the time a program is taking place, or by randomly assigning applicants to a program into "treatment" and "control" groups. However, because of the retrospective nature of this study, that process could not be used. Instead, it was decided to use a comparison group drawn from an existing national dataset – the Beginning Postsecondary Student Survey. While the use of an existing dataset offers some challenges, it does provide an opportunity to create a well-matched comparison group where other types of comparison group procedures are not possible.[3]

In this instance, the Beginning Postsecondary Survey offered the opportunity to generate a well-matched comparison group. BPS data included extensive information on the demographic and high school academic background of students in the dataset, making it possible to select a comparison group that came from similar socioeconomic backgrounds and had similar levels of academic achievement in high school. At the same time, the BPS dataset provided information on key outcomes of interest for FIRST, including college major, expected career choice, and

[3] There are several major challenges in using an existing dataset to construct a comparison group. The first is that it limits the questions that can be addressed to those already available in the existing dataset. In this instance, for example, the BPS dataset included information on students' college major (a key outcome for FIRST), but not on college courses or the types of jobs students had during college. As such, while the BPS data can be used to compare FRC participants with BPS students on some outcomes, there are other outcomes for which no comparison data are available.

Similarly, the "baseline" data that can be used in constructing the comparison group is also limited. In this case, for example, participants and comparison students can be compared in terms of demographic characteristics and academic background. However, it is possible that FRC participants differ from comparison students on some unmeasured characteristics, such as motivation, that could affect their outcomes. As such, the opportunity to use a matched comparison group provides a much higher degree of control than comparisons to the student population at large, but the absence of a full set of baseline controls needs to be recognized.

The other key issue involved in using an existing database like BPS is that of the timing of the data collection. In this instance, the BPS dataset includes students who began college in 1995-96 (the most recent year for which this type of comparison data was available); the FRC students generally graduated high school several years later (1999-2003). While there is nothing to suggest that the trends in key college outcomes (majors, etc.) changed significantly during that time period, it is important to recognize that the "match" between participants and the national comparison group is not exact.

college internships and grants, as well as several measures of community involvement and personal goals. While the BPS data could not provide a match for every measure of interest for FIRST (for example, all students in the BPS dataset attended college, so the data could not be used to assess relative levels of college-going), it did make it possible to construct a matched comparison for a number of core outcomes for FIRST.

Table 1-1 provides a list of the variables that were used in creating the matched comparison group for this study. To accomplish that, the respondents to the FRC survey were matched to students with similar demographic and academic backgrounds in the BPS dataset through a process known as "propensity score matching." Under that procedure, a single, summary "propensity score" was created for each FRC survey respondent and each student in the BPS dataset based on the demographic and academic measures listed in Table 1-1. That score was then used to match each FRC respondent to an individual in the BPS dataset with the same or closest available propensity score.[4] In the end, usable matches could be made for 147 FRC participants and an equal number of students from the BPS dataset. That group of 294 cases was used for the comparative analysis.[5]

Table 1-1: Variables Used in Creating the Matched Comparison Group

Demographic Background Measures	High School Academic Background Measures
▪ Race (White/Non-White) ▪ Gender (Male/Female) ▪ English as a second language ▪ Parent's education (whether at least one parent attended college) ▪ Economic status of the high school (percent of students eligible for free/reduced cost lunches)	Whether students had taken following courses: ▪ honors math class ▪ one honors science class ▪ at least one math class (from a list that included Algebra 1 and 2, Trigonometry, Geometry, Calculus, etc.) ▪ at least one science class (from a list that included Biology, Chemistry, Physics, etc.)

Participant Outcomes Analysis. Given the availability of a matched comparison group for the analysis of some, but not all of the outcomes in the study, the participant outcome analyses in Chapters 3 and 4 looks at participant outcomes in three ways:

- *Participant perspectives*. Chapter 3 focuses on the participants' own assessments of the quality of their program experience and the impact of the program on their interests and

[4] Propensity scores have become a widely used method of creating matched samples and/or adjusting for differences in baseline characteristics among samples in evaluation studies. See, for example, the recently released evaluation of the national AmeriCorps program, Abt Associates, Inc., *Serving Country and Community: A Longitudinal Study of Service in AmeriCorps* (Washington, D.C.: Corporation for National and Community Service, December 2004). A number of scholars, however, have highlighted the limits of propensity score matching, reminding users that propensity scores cannot adjust for unobserved or unmeasured differences between groups. A recent paper by Roberto Agodini and Mark Dynarski reinforces that point and argues caution in using propensity scores in place of more traditional, random assignment approaches. See Robert Agodini and Mark Dynarski, "Are Experiments the Only Option? A Look at Dropout Prevention Programs," Mathematica Policy Research, August 2001. Available at www.mathematica-mpr.com/publications/PDFs/experonly.pdf.

[5] Approximately 26 FRC students were dropped from the matching process because of missing data for one or more of the matching variables. It is worth noting that a number of other variables were considered for use in the matching process, including SAT/ACT scores and participation in specific academic classes, such as Physics or Calculus. However, in each case, missing data on those variables from the FRC cases would have reduced the size of the sample too much to work with.

skills, based on participant responses to questions on the FRC survey.

- *Comparisons to National Averages*. The first part of Chapter 4 then looks at a variety of more objective career, education, and developmental outcomes, including measures of college-going, college major, and educational aspirations, and where possible, compares them to available national averages for all students or for students in appropriate demographic groups (race and gender). In this instance, the national data provide one useful benchmark for interpreting the FRC results, comparing outcome for FRC alumni to all students. However, it is important to recognize that this is a relatively rough comparison since the national averages include a wide range of students, including those with different socioeconomic and academic backgrounds. As such, they are not as accurate a comparison as a matched comparison group, but for a number of measures, they are the best point of comparison available.

- *Matched Comparison Group Analysis*. The second part of Chapter 4 then examines a smaller set of career, education, and developmental outcomes in comparison to those of the matched comparison group to assess the relative impact of the program. While all three types of analysis (participant perspectives, national averages, and matched comparison group) provide useful data for assessing the impact of the program, this matched comparison group analysis provides the most rigorous and reliable assessment of the impact of FRC on the students in the study.

Site Visit Interviews. The other major element of the study was a series of site visits to approximately 10 FIRST teams in New York and the Detroit/Pontiac metropolitan areas (Table 1-2 lists the schools visited). Site visits generally lasted up to a day in length and included interviews with team leaders, school administrators, mentors, and students. Major topics for the site visits included the following:

- Team operations and best practices
- FRC impact on the schools
- Impacts on team leaders
- Mentor roles and impacts on mentors and the sponsoring organizations

In each case, the goal of the site visit was to help better understand the context in which the FIRST Robotics Competition took place and to determine whether involvement in FRC had impacts beyond those on the participating youth.

Table 1-2: Site Visit Locations

School	Location
Morris High School	NYC (Bronx)
McKee Vocational Technical High School	NYC (Staten Island)
Brooklyn Technical High School	NYC (Brooklyn)
George Westinghouse High School	NYC (Brooklyn)
Washington Irving High School	NYC (Manhattan)
Pontiac Central High School	MI (Sterling Heights/Pontiac)
Buena Vista High School	MI (Saginaw)
Hamtramck High School	MI (Detroit)
Osborn High School	MI (Detroit)
Cooley High School	MI (Detroit)

CHAPTER TWO
PARTICIPANTS IN THE FRC STUDY SAMPLE

One of the key goals for this study was to document the impact of the FIRST Robotics Competition on students from schools serving predominantly low income and minority communities. This reflected the desire on the part of FIRST to expand the program in those communities and to involve more low income and minority young people in the program. As such, an assessment of the effectiveness of the program in those underserved schools, as well as others, was seen as an important element in the program's growth. As a result of this, the design for the study called for the evaluation to focus on schools with substantial numbers of students who were low income and/or minority and to do so by drawing its sample from teams in major metropolitan areas.

To accomplish this, approximately 35 teams from New York City, the Detroit/Pontiac metropolitan area, and the San Jose/San Francisco Bay area were invited to participate in the study. The teams included in the original sample included all of the teams in each area that had been in operation for two or more years, and most reported relatively high proportions of low income or minority students. Ultimately, fourteen teams, primarily from the Michigan and New York areas agreed to participate in the study and were able to provide contact information for past participants in the FRC program. The teams that declined to participate generally did so either because the school was no longer actively involved in FIRST or because the team could not provide any information on former participants.

CHARACTERISTICS OF SCHOOLS IN THE STUDY

Table 2-1 provides an overview of the demographic characteristics of the schools involved in the study, based on data from the U.S. Department of Education, National Center for Educational Statistics database. In large part, the teams in the study met the criteria that they be located in schools serving large percentages of low income or minority students. Of the sites with available school-wide data, nine of eleven had more than 60% non-white students, and 6 were over 95% non-white. Nine of eleven schools with available data had more than 50% of their students eligible for the federal free and reduced price lunch program, a widely used indicator for services to low income families.[6] At least a third of the schools were also Title I eligible, another benchmark indicating high proportions of low income and/or educationally disadvantaged students.

[6] Federal guidelines provide that students in families with incomes below 130% of the federal poverty level qualify for the federal free lunch program; students in families with an income below 185% of the poverty rate qualify for the reduced cost lunch program. Data on race and ethnicity and free lunch status were not available for three teams/schools. The Eden Area Regional Occupational Program (Alameda County, CA) and Oakland (Michigan) Northeast Tech Center are regional technical schools that draw students from a variety of area schools, and the North Oakland County (Michigan) schools team drew students from a consortium of schools.

Table 2-1: Survey Sample Sites

School	Number of Students	Title One School	Percent Non-White	Percent Free and Reduced Cost Lunch
New York City				
Westinghouse HS	1159	Yes	98.3%	67.0%
Gompers HS	1340	Yes	98.9%	95.2%
Morris HS	1604	Yes	99.3%	40.8%
Canarsie HS	2370	No	97.0%	51.2%
Curtis HS	2323	No	61.6%	61.0%
Washington Irving HS	2861	Yes	96.9%	78.6%
McKee HS	548	No	71.7%	60.8%
Staten Island Vocational HS	732	No	17.9%	3.1%
Michigan				
Hamtramck HS	1009	Yes	42.5%	82.5%
North Oakland County Schools	NA	NA	NA	NA
Oakland Tech Center NE	NA	NA	NA	NA
Osborn HS	2008	NA	98.7%	53.2%
Pontiac Central HS	1276	NA	85.3%	58.7%
California				
Eden Area ROP	NA	NA	NA	NA

Note: Data from the National Center on Educational Statistics, U.S. Department of Education, Common Core of Data, 2002-2003, available on the NCES website: http://nces.ed.gov. Additional data on New York City schools drawn from individual school "Report Card" data available at http://www.nycenet.edu. NA indicates data not available.

PARTICIPANT CHARACTERISTICS

The FIRST participants who responded to the survey also meet the study criteria, representing a diverse group that includes a substantial proportion of minority students, women, and young people from families with a limited educational background. As Table 2-2 shows:

- The team members who responded to the survey were a racially and ethnically diverse group: overall 44% of the survey respondents were white, and 56% were African-American, Asian, Hispanic, Native American, or multi-racial.

- Fifty-nine percent of the respondents were male, 41% female.

- Thirty-seven percent of the respondents came from families where neither parent had attended college, including 2-year or community college; another 32% came from families where only one parent attended college. Looking at the data another way, less than one quarter (22%) of the team members came from families where both parents graduated from a two or four-year college.

At the same time, the FIRST participants in the study were also largely successful students in high school. According to the grades and test scores they reported on the survey, the average team member in the study had a high school Grade Point Average of 3.5 (roughly a B+) and more than 80% reported a 'B' average or above for their high school years. Sixty one percent of the students took at least one honors course in high school, and slightly more than half (51%) of all students in the sample took an honors course in math or science.

Table 2-2: Participant Characteristics

Characteristic	N	Percent
Race/Ethnicity		
African-American	28	16.4%
Asian/Pacific Islander	27	15.8%
Hispanic/Latino	18	10.5%
Native American/Alaskan	1	0.6%
White	76	44.4%
Multi-Racial	20	12.3%
Gender		
Male	97	59.4%
Female	68	40.6%
Parents' Education		
No College - Either Parent	53	36.8%
Some College - One Parent	46	31.9%
Some College - Both Parents	45	31.3%
No College Degree (AA Degree or higher) – Either Parent	84	58.3%
College Degree (AA Degree or higher) – One Parent	29	20.1%
College Degree (AA Degree or higher) - Both Parents	31	21.5%
High School Academic Achievement		
Mean Grade Point Average (Self-Reported)	166	3.5
Students reporting a B average (GPA) or above	139	83.7%
Student who took at least 1 honors class in high school	106	61.3%
Students who took at least 1 honors class in science or mathematics in high school	88	50.9%
Test Scores		
Percent of Students taking SAT or ACT	153	88.4%
Mean SAT score (Math and Verbal Combined)	47	1195
Mean ACT score (Math and Verbal Combined)	52	24
High School Math and Science Courses		
Four or more years of mathematics Courses	138	79.8%
Four or more years of science Courses	107	61.8%

Note: Based on FRC survey data. N=173. Percentages are based on valid (i.e., non-missing) responses for each item.

SAT and ACT participation was also high, as were the average scores among those who reported them. Nearly 90% of the team members in the survey reported taking the SAT or ACT exams, reflecting a high degree of interest and intention in going to college. Among those who reported SAT scores, the average score was 1195 for combined verbal and math (out of a possible 1600);

on the ACT the average scores was 24 out of a possible 36.[7] In both cases, students in the sample scored well above the national averages for the SAT test (1026) and for the ACT (20.9).[8]

Finally, a high proportion of students in the survey reported taking math and science classes throughout high school. Overall, 80% of the team members took a full four years of math classes and 62% took four years of science. In both cases, these figures were roughly 10% above the national averages for college-oriented students.[9]

In sum, the team members in the study represent, on average, a group of relatively high achievers in high school, but they also represent a diverse set of backgrounds, including a high proportion of students from underserved schools and from families where neither parent was a college graduate. That mix of characteristics sets an important context for understanding the post-high school careers of the FIRST alumni.

One of the questions that cannot be answered here (because we do not know about students' academic performance *before* involvement in FIRST) is the relationship between student achievement in high school and involvement in the FIRST Robotics Competition. Were students motivated to a higher level of achievement in high school as a result of participation in FIRST, or did FIRST tend to attract and admit students who already had a record of high achievement, or something between? The interviews conducted during the site visits for this study suggest that the students in FIRST represented a mix of backgrounds, interests, and capabilities – not just students who were each schools' high achievers. In a number of sites, team leaders did establish a set of minimum grade requirements for participation in the program (similar to the requirement for a passing grade to participate in varsity sports). In some cases, those requirements may have created a barrier to participation by lower achieving students. In other cases, engagement in FIRST, reinforced by those requirements, may have helped to motivate students to do well in school in order to stay on the team. In still other cases, FIRST may have provided an outlet or a new challenge for students who were already successful in school. Future studies may help sort out these mechanisms more clearly. In the meantime, the survey results reported here suggest that for most of the students in FIRST, the longer-term results of the FRC connection were positive.

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[7] It is worth noting that only half of those who reported taking the SAT or ACT exams also reported their total score on the survey. As such, the average scores need to be treated with some caution. However, even assuming some degree of upward bias in the reporting, the test scores suggest that the FIRST participants in the sample represented a group of students with a solid academic background.

[8] National averages are for 2004. See The College Board. *2004 College Bound Seniors; A Profile of SAT Program Test Takers* (2004) and "Average ACT Scores by State: 2004 ACT-Tested Graduates" on the ACT website: http://www.act.org/news/data/04/states.html.

[9] National averages are based on data for high school seniors who took the SAT in 2004. See College Board, *College Bound Seniors: A Profile of SAT Program Test-Takers* (2004). Nationally 71% of SAT-takers in 2004 reported four or more years of mathematics in high school; 52% reported four or more years of science.

CHAPTER THREE
THE FIRST EXPERIENCE – TEAM MEMBERS' PERSPECTIVES

Regardless of background, for the young people in the study, FIRST provided a positive experience that gave them an opportunity to be involved in a team activity, build relationships, learn new skills and gain a new understanding of and interest in science and technology. Based on the survey responses, FIRST provided many participants with the kinds of experiences that are considered important to effective youth development (detailed later), and for a substantial number of alumni, was seen as one of the most influential experiences in their high school careers.

INVOLVEMENT IN FIRST ACTIVITIES

According to the team members' surveys, the FIRST experience varied widely from participant to participant, both in terms of the level of overall involvement in the program and the specific tasks that team members were involved in during their time on the team. On average, team members in the study were involved in FIRST for two years, most commonly during their junior and senior years in high school (Table 3-1). During those years, students varied widely in the types of activities in which they were involved. The most common activity, reported by over 90% of the survey respondents, was attending a FIRST regional event. Apparently, even for teams in lower income communities (where travel funds might be limited), most team members had an opportunity to directly experience an FRC regional competition.

However, there was considerable variation in the degree of participation in the team members' other activities:

- Roughly 60% to 70% of the team members reported involvement in the core team activities of deciding on the overall team strategy (62%), designing the robot or a specific part (68%) and building the robot or a part of the robot (71%).

- Involvement in more specialized tasks, or direct involvement in the Competition activities, was generally lower. Only 20% of the team members reported involvement in programming the robot; 53% reported working on or operating the robot at the competition; and 34% reported making a presentation to the judges at the competition. Similarly, the percentage of team members involved in preparing a computer animation (23%) or in building a team website (19%) were relatively small.

- Finally, more than half of the team members reported participating in what might be characterized as team-related activities. Specifically, most alumni reported being involved in raising money or promotional activities for the team (79%); a smaller but still substantial proportion (56%) participated in team community service activities.

Table 3-1: Participation in FIRST Activities

Characteristic	N	Percent*
Attending a FIRST regional competition	163	94.2%
Raising money or doing publicity for the team	137	79.2%
Attending a FIRST national competition	132	76.3%
Building the robot or a specific part of the robot	123	71.1%
Designing the team's robot or a specific part of the robot	118	68.2%
Deciding on the team's overall strategy for the competition	108	62.4%
Participating in a community service project with your team	97	56.1%
Working on or operating the robot at a FIRST regional competition	91	52.6%
Making a presentation to the judges at a FIRST regional competition	59	34.1%
Developing the team CAD/CAM presentation	40	23.1%
Programming the robot	35	20.2%
Designing or building a team website	33	19.1%
Level of Involvement in the Team/Program: Scale from 1 (Not Involved) to 5 (Very Involved)		
Very Involved (5)	72	43.1%
Involved (4)	58	34.7%
Somewhat Involved (3)	24	14.4%
A little involved (2)	13	7.8%
Not involved (1)	0	0.0%
Number of Years in FIRST		
One	65	37.6%
Two	50	28.9%
Three	31	17.9%
Four	27	15.6%
Average years in FIRST	173	2.1

Note: Based on FRC survey data. N=173. Percentages are based on valid (i.e., non-missing) responses for each item. * Percent of respondents who indicated involvement in the specified activity in at least one year in high school.

Much of the variation in program involvement likely reflects the division of labor that takes place on many teams as team members are split off into groups focused on designing, building, programming, or operating the robots, or in pursuing other team components like the website. However, despite the variations, most team members saw themselves as actively involved in the program. When asked to assess their overall involvement, 78% had rated their level of involvement as a 4 or 5 on a scale of 1 to 5, with 5 indicating "very involved." Forty-three percent had checked off the top level of involvement on their surveys.

QUALITY OF THE FIRST EXPERIENCE

For most participants, FIRST was also a fun and engaging experience that provided opportunities to take on real responsibilities, work as a team, and gain a sense of belonging. These aspects of FIRST are particularly important because they parallel the types of experiences that research has indicated are associated with effective youth development programs. According to the National

Research Council's recent report, *Community Programs to Promote Youth Development*, effective programs provide young people with some or all of the following characteristics:[10]

- A safe environment (a physically and socially safe setting)
- Appropriate structure (clear rules and expectations)
- Supportive relationships (caring, support, guidance)
- Opportunities to belong
- Positive social norms (including obligations for service)
- Support for efficacy and mattering (youth decision-making, making a real difference, responsibility and challenges)
- Opportunities for skill building
- Integration of family, school and community.

Based on the alumni surveys, FIRST was seen by participants as providing many of these types of experiences (Table 3-2):

- Alumni felt that FIRST involved them in real and challenging tasks. Seventy-four percent reported that students made the important decisions, 89% indicated that they had 'real responsibilities," and 76% reported that they had a chance to play a leadership role on the team.

- Most felt they had a chance to do a variety of tasks (87%) and to learn new skills while on the team (94%).

- FIRST also gave students a chance to belong and to experience supportive relationships with caring adults: 95% reported getting to know an adult very well and 91% indicated they felt they learned a lot from the adults on the team. Ninety-one percent felt that they "really belonged on the team."

- Finally, FIRST provided an opportunity to enjoy working as a team (96% reported having fun) and to experience a sense of competency and success: 92% reported almost always feeling like they had a chance to win.

The only finding of concern in this context is that 50% of the alumni reported that the adults on the team did most of the difficult jobs involved in building the robot.[11] This is always a concern in this kind of competitive environment, and one that requires a balance between the desire to win on all sides and the need to provide team members with a hands-on, empowering experience. One area FIRST may want to continue to work on is in providing guidance to team leaders and

[10] See Jacquelynne Eccles and Jennifer Appleton Gootman, Editors, *Community Programs to Promote Youth Development* (National Research Council and Institute of Medicine, 2002).

[11] This issue was also identified by survey respondents in responses to an open-ended question about what they like least about FIRST. Twenty two of the 133 responses to that question (17%) mentioned issues with adults working with the team. The most common of these concerned adults "hoarding" the design and construction process, not enough hands-on work for students, or adults who were overly-concerned with winning. Other concerns raised included team conflicts, problems raising funding, the short build season, etc., with each category mentioned by roughly 5-12 of the respondents. Responses to the open-ended questions are discussed in more detail later in this chapter.

mentors on appropriate roles for adults and how best to support team members while allowing them to do more of the work on the Competition.

Table 3-2: Quality of the FIRST Experience

Characteristic	N	Percent*
I had fun working on the FRC team.	164	95.9%
I had a chance to get to know at least one of the adults on my team very well.	163	95.3%
I learned new skills while working on the team.	161	94.2%
I almost always felt that my team had a good chance to win something at the regional competition.	157	91.8%
I felt like I learned a lot from the adults on my team.	157	91.0%
I felt like I really belonged on my team.	155	90.6%
I had real responsibilities on my team.	153	89.0%
I had a chance to do lots of different jobs on my team.	150	87.2%
I had a chance to play a leadership role on my team.	131	76.2%
Students on my team made the important decisions, not the adults.	127	73.8%
The adults on my team did most of the difficult jobs in building the robot.	86	50.0%

Note: Based on FRC survey data. N=173. Percentages are based on valid (i.e., non-missing) responses for each item. * Percent of respondents who "agreed" or "strongly agreed" with the statement.

IMPACTS ON KNOWLEDGE AND BEHAVIOR

FIRST participants also reported a variety of positive impacts from their participation in the program, ranging from an increase in self-confidence to a better understanding of math and science and an increased interest in math, science or technology careers (Table 3-3). According to the surveys, FIRST helped young participants:

- Increase their understanding of the value of teamwork (95%) and of the role of 'gracious professionalism' in everyday life (83%).

- Increase their understanding of the role of science and technology in everyday life (89%), their interest in science and technology generally (86%), and their interest in science and technology careers (69%)

- Increase their sense of self-confidence (89%) and their motivation to do well in school (70%).

Finally, FIRST also helped to increase participants' interest in serving others, with 65% of participants reporting that they wanted to help younger students learn about math and science, and with more than half (52%) reporting that, as a result of FIRST, they had become more active in their community.

Table 3-3: Impacts from the FIRST Experience

Characteristic	N	Percent*
FIRST helped me understand the value of working on a team	164	94.8%
I gained a better understanding of how math, science and technology are used to solve problems in the real world	154	89.0%
I gained a sense of self-confidence by being in FIRST	152	88.9%
My interest in science and technology greatly increased as a result of being in FIRST	148	85.5%
FIRST helped me understand the role of 'gracious professionalism' in everyday life	143	82.7%
FIRST helped motivate me to do better in school	120	69.8%
I became more interested in a career that involved math, science or technology as a result of FIRST	119	68.8%
I gained a better idea of what I wanted to study in college or vocational school as a result of FIRST	116	67.1%
FIRST made me want to help younger students learn more about math and science	113	65.3%
I became more active in my community as a result of FIRST	90	52.0%

Note: Based on FRC survey data. N=173. Percentages are based on valid (i.e., non-missing) responses for each item. * Percent of respondents who "agreed" or "strongly agreed" with the statement.

IMPACTS ON PARTICIPANT SKILLS

The large majority of participants also reported that FIRST had helped them gain a variety of communications, interpersonal, and problem-solving skills. Overall, more than two-thirds of the participants (and in most cases well over 80%) reported that FIRST had helped them "a lot" (the highest response category) in learning a wide variety of skills (Table 3-4):

- More than 90% reported learning important communications skills, such as how to listen and respond to other people's suggestions (94%) and how to talk with people to get information you need (94%). A smaller, but still substantial percentage (73%) reported learning how to make a presentation in front of people they did not know.

- Students also learned teamwork and interpersonal skills. Ninety-two percent reported learning how to get along with other students, co-workers, teachers and supervisors; 90% learned to work within the rules of a new organization or team; 88% reported learning new ways of thinking and acting from others; and 73% learned ways to stop or decrease conflicts between people.

- Students learned problem-solving and time management skills as well. Students reported learning how to solve unexpected problems or how to find new or better ways of doing things (93%); how to manage their time under pressure (90%); how to weigh issues and options before making decisions (94%); and how to gather and analyze information (88%).

- Finally, students also learned to apply traditional academic skills in real-world settings: 68% reported learning how to use computers to retrieve and analyze data, and 67% reported learning about using practical math skills such as using graphs and tables or estimating costs.

Table 3-4: Skills Gained Through FIRST

Characteristic	N	Percent*
Weigh different issues and possibilities before making a decision	162	94.2%
Listen and respond to other people's suggestions or concerns	162	93.6%
Talk with people to get the information you need	162	93.6%
Solve unexpected problems or find new or better ways to do things	161	93.1%
Get along with other students, co-workers, teachers, and supervisors	159	91.9%
Work within the rules of a new organization or team	155	89.6%
Manage your time when you are under pressure	155	89.6%
Learn new ways of thinking or acting from other people	152	88.4%
Know how to gather and analyze information from different sources	152	87.9%
Make a presentation in front of people that you do not know	126	73.3%
Stop or decrease conflicts between people	126	72.8%
Use computers to get or analyze information	117	68.4%
Use practical math skills, such as graphs, tables, or estimating costs	116	67.1%

Note: Based on FRC survey data. N=173. Percentages are based on valid (i.e., non-missing) responses for each item. *Percent of respondents who indicated that their FIRST team had helped them learn the specified skills "A Lot." Other response categories were "Some", "Very Little" and "Not at All".

Taken together, these skills represent the kinds of practical, "workplace skills" that have increasingly been called for by employers over the past decade and are seen as a critical part of the preparation of young people for the world of work.[12] While FIRST is not seen as a "school-to-career" program *per se*, the development of these kinds of practical, work-related skills is seen as an important part of helping prepare participants for long-term success in their careers.

OVERALL SATISFACTION.

As the foregoing suggests, FIRST alumni evidenced a high degree of satisfaction with their program experience as a whole (Table 3-5). When asked to look back and assess their experience in FIRST, nearly 70% rated it as excellent and another 27% as good. Less than 5% of the survey respondents rated their experience as "fair" or "poor."

[12] One useful definition of critical workplace skills is the set of "SCANS Skills" developed by the U.S. Labor Department in its report on the Secretary's Commission on Achieving Necessary Skills (SCANS). See the Commission report: *What Work Requires of Schools* (1991). The SCANS skills include foundation skills, such as basic reading and math competency, thinking and decision-making skills, and interpersonal skills, as well as workplace competencies, including the ability to manage resources, work with diverse others, gather information, understand systems, and make effective use of technology. In their study of the employment requirements of successful firms, Richard Murnane and Frank Levy identify a similar set of "new basic skills" required to earn "a middle class wage." These included solid reading and computational skills, but also included problem-solving, ability to work in a team, communications skills, and ability to use a computer. See Murnane and Levy, *Teaching the New Basic Skills* (New York: Free Press, 1996).

Table 3-5: Overall Assessment of FIRST Experience

Characteristic	N	Percent
Overall, how would you rate your experience in FIRST		
Excellent	117	68.0%
Good	47	27.3%
Fair	6	3.5%
Poor	2	1.2%
How important an influence was FIRST, compared to other activities you were involved in?		
Much more influential	78	45.9%
A little more influential	51	30.0%
About the same as other activities	33	19.4%
A little less influential	5	2.9%
Much less influential	3	1.8%

Note: Based on FRC survey data. N=173. Percentages are based on valid (i.e., non-missing) responses for each item.

Similarly, the majority of alumni saw FIRST as one of the more influential experiences in high school. When asked to compare the influence of FIRST to other extracurricular activities, nearly half (46%) reported that FIRST had been "much more influential" and another 30% reported that FIRST had been "a little more influential" compared to their other activities. Roughly 20% of the survey respondents reported that FIRST had the same influence as other activities, and less than 5% saw it as less influential.

PARTICIPANT COMMENTS/REFLECTIONS

The high level of satisfaction with the FRC experience was also evident in the responses to the survey's open-ended questions. The survey included several open-ended questions, asking what had been the most important part of the FIRST experience for the respondent; what the respondents had liked least about the program or thought should be changed; and what impact the program had on the participant. In each case (including the responses concerning what was liked least about the program), the comments reflect a sense from the large majority of participants that FIRST had been a rewarding and influential experience in their lives. At the same time, the responses also provide some further insights into the nature of the FIRST experience.

The Team Experience as Key. In responding to the question about what aspect of FIRST had been most important, FRC alumni most frequently pointed towards the team experience – learning how to work as a team, interacting with others, and working towards a common goal – and the relationships that came from that as the most critical part of their experience. Nearly half of the respondents (71 of 162, or 44%) highlighted the teamwork experience as the most important aspect of FIRST (see Table 3-6), with a substantial number making a similar, related point on the development of personal relationships through the team process (44 respondents, or 27%). Smaller percentages of FRC alumni mentioned the Competition experience as particularly influential (15%); the experience of setting and accomplishing goals/having pride in their accomplishments (9%); learning new skills (9%) and learning about technology and engineering (7%). A sampling of typical comments can be found below.

Table 3-6: Responses to Open-Ended Questions on FIRST Experience

Characteristic	N	Percent
What aspect of FIRST had the greatest impact on you? What was the most important part of the FIRST experience? (162 responses)		
Team/Group Work	71	43.8%
Making Personal Connections	44	27.2%
Competition Experience	24	14.8%
Setting and Accomplishing Goals/Pride in the Work	14	8.6%
Skill Building	12	7.4%
Learning about Engineering/Technology Careers	11	6.8%
What did you enjoy least about your time in FIRST? What would you change? (133 responses)		
No Changes	23	17.3%
Adults (Parents, Teachers, Advisors)	22	16.5%
Team Problems/Conflicts	12	9.0%
Money/Funding	11	8.3%
Student Involvement in Project	11	8.3%
Can you give an example of how your FIRST experience has made a lasing impact on you (if it has) since high school ? (143 responses)		
Relational Skills	32	22.4%
Interest in Technology/Related Fields	27	18.9%
Confidence/Inspiration	24	16.8%
Influence on Career	18	12.6%
Friendships/Relationships Formed	16	11.2%
Influence on Academics	16	11.2%
Skill building	10	7.0%
No Impact	9	6.3%

Note: Based on the FRC survey. Percentages are based on the number of respondents who cited each topic. Some responses to each question were counted in more than one response category, (for example, a response might have mentioned both Team/Group Work and Skill Building).

- *The most important part of the FIRST experience for me was being part of a team and learning the skills to achieve a common goal.*

- *The aspect of FIRST that had the greatest impact, or influence, on me was probably the interaction with a team. I have been on many teams, mostly for sports. The FIRST team, however, taught me a lot about interacting with people who were very different from one another. On sports teams, everyone is very similar and has a common interest in the sport. In FIRST, however, each person is very different. I was therefore forced to learn how to interact with, and get along with, very different people.*

- *The most important aspect of FIRST for me was the friendships I made and developed while on the team.*

- *Going to the regional competition had the greatest impact on me. It was different being able to see something that has to do with science, math and building robots come together while being fun.*

- *The feeling of accomplishment. Working day and night (literally) to design and build an ingeniously designed robot and having it perform well was the most important part of my FIRST experience. It just showed that you can do anything you put your mind to. Anything is possible.*

Ensuring a Hands-On Experience. Two points stood out in the response to the question about what participants enjoyed least or wanted to change about FIRST. The first was that the most frequent response (17% of the respondents) was that no changes were needed: "Truthfully, I would change nothing." "There is nothing to change, everything was great."

Among those with concerns, however, the most consistent issue (as noted earlier) was that of adults taking over the process and/or not allowing students to do enough of the hands-on work in building the robot. Just under 17% of the respondents (the most common category after "no changes") noted concerns with the roles played by the adults. While the students recognized that FIRST was intended to be a learning experience for them, it appears that at times the adults needed to be reminded.

- *The adults did too much work. It should be the kids' way to learn, not who would win.*

- *I didn't really care for the overpowering adults. The adults (teachers in particular) would always tell us how important winning was. I didn't look at it that way. I looked at the skills I was gaining, the people I was getting to know, and fun that I was having while learning new things. In fact, I would be willing to say that most of our team at that time felt that way.*

- *What I enjoyed least about my experience on FIRST is that sometimes the adults forget that FIRST is not just educational and not just a competition, but it is supposed to be fun as well.*

Others also noted a frustration with the lack of hands-on opportunities (approximately 8%), both because of adult involvement and because of the short-time frame of the competition and the need to split tasks up within the teams. The basic message across both sets of responses was the importance of ensuring that students have a real chance for hands-on experiences.

Other issues that were noted included problems with team conflicts, such as issues of favoritism and the need for more team-building skills (9%), and the difficulty of raising funds and the high costs of participation (8%). Smaller numbers of students also mentioned issues ranging from the time pressure of the competition to the fact that teams couldn't afford to bring all members to the competitions.

Lasting Impacts: Relational Skills and an Interest in Science and Technology. When asked about FIRST's lasting impacts, FRC alumni made it clear that whatever concerns were raised were in the context of a program that had made a significant difference in their lives: from their perspective, FIRST had achieved its goals of building skills and inspiring young people to think in new ways about their future.

Not surprisingly, given the emphasis on the teamwork experience in other responses, the most consistent impact cited by participants was the development of teamwork skills (22% of

respondents). Participants saw FIRST as having provided critical experience in working with diverse team members, hearing and giving feedback, respecting the ideas of others, and similar skills critical to success in the modern workplace.

- *I've learned how to work well with a group of people who all have their own ideas and solutions to problems, and to organize the situation in a productive manner. This has helped me in many different aspects [of my career]….*

- *The competition has shown me how to be receptive to others opinions and ideas.*

- *The college I go to has many students from different backgrounds. I am able to work in group projects very well because of all the teamwork I experienced during FIRST.*

- *Anytime I work in a group or team oriented project, I always think about preparing for the FRC and how as a group we interacted and listen to each other in order to solve a common problem.*

For many, FIRST also succeeded in its goal of generating and/or supporting participants' interest in science and technology. Roughly 20% of the respondents cited an increased interest in science and technology as a major impact from the program, with another 13% (with some overlap between the two) noting that the program had influenced their choice of career.[13]

- *I think about technology in a new way now, thanks to the time spent on the robotics team with FIRST.*

- *I chose my major in college because of it. I joined the Society of Women Engineers to get more women involved in engineering.*

- *Because of my experience in FIRST robotics, I received an internship at General Motors after I got out of high school, which gave me good job skills and people interaction in a real, career-type setting. I also allowed me to see what a real career in engineering is like. FIRST was able to show me to stay on top of my goals and keep focused.*

- *FIRST has literally changed my life….I never had a strong interest in math or science until my eleventh grade year when I joined a FIRST team. FIRST made me see that science and math are something that I not only am interested in, but truly enjoy doing every day. FIRST opened a door to a whole new world, a world I wanted to stay in. I would have to say that FIRST is the reason why I will be an engineer someday….*

In many cases, the comments about FIRST's influence on interests and careers were combined with reflections on an increased sense of self confidence and purpose. Seventeen percent of the responses mentioned confidence and inspiration explicitly in one way or another:

[13] It is important to note that these are responses to an open-ended question about impacts. As noted earlier, well over 80% of the participants overall reported an increased interest in science and technology in response to a more specific survey question (see Table 3-3).

- *It has given me the confidence to try new things. I've gained an experience that I would never have thought possible. I work better with people and build a major interest in technology.*

- *FIRST was a program that helped me, as a female, realize I was just as good, if not better, than the boys, and I could be an engineer. It is the part of high school that I look back at and wish I could do over and over again, and it is where I met some of my best friends and mentors.*

- *Being on a small team and accomplishing a great task enabled us to extend our thinking and discover our hidden capacities.*

- *FIRST has taught me not to give up on anything I want to achieve in life. I've been taught that nothing in life is worth having if it is only handed to me. Plus it's much funner [sic] to have a challenge and find a way to get through it. It helps to build character. That is what FIRST is about to me. An organization that builds peoples' character by having them look in themselves to see that they can do anything. It just takes a little work, as well as some friends.*

As a whole, the responses to the open-ended questions reinforce the more quantitative results from the FRC survey. Both implicitly and explicitly, the responses indicate that, for these former participants, FIRST had been an engaging and influential experience. By their own accounts, it helped teach them critical life skills, exposed them to the world of science in technology in a way that expanded their interest in those fields, and helped them build the confidence and relationships that they needed to move forward with their education and their careers.

SUMMARY: PARTICIPANTS' PERSPECTIVES

Taken together, the survey responses indicate that, for a substantial number of young people, FIRST provided a valuable learning experience that contained many of the elements of effective youth and career development programs. It is important to recognize that the positive assessments by FIRST alumni may reflect a degree of self-selection, with those with strong feelings about the program (both positive or negative) more likely to return their surveys. However, that said, it is clear that for vast majority of those surveyed, FIRST was a valued and valuable experience, providing opportunities to belong, to learn new skills, and to gain a new understanding of the role of science and technology in everyday life.

CHAPTER FOUR
EDUCATION, CAREER, AND DEVELOPMENTAL OUTCOMES

While the participants' retrospective assessments provide one measure of FIRST's impact on team members, the ultimate measures of FIRST's effectiveness are the degree to which its alumni go on to have productive educational experiences, careers, and lives in their communities. As the questions posed at the beginning of this report ask: Are FIRST participants more likely to graduate high school, go to college, and take courses or pursue a career in science and technology than similar, non-participating students? What impact does FIRST have on low income, women, and minority students who are often under-represented in science and technology programs and careers?

It is important to note that there is some dispute among supporters of FIRST about the best yardstick to be used in measuring the success of the FRC. For some, FIRST is seen primarily as a youth development effort aimed at promoting an interest in science and technology and educational and career success in broad terms. In that regard, any increase in high school graduation, college-going, and school success would be seen as a win – especially for students in underserved schools. For others, FIRST's commitment to promoting science and technology is a more central and compelling goal. For those stakeholders, the key measure is not only general education and career success, but also increased involvement specifically in *science or technology-related* education and careers.

The analysis of the alumni survey data strongly suggests that FIRST is successfully meeting both of these benchmarks. According to the survey data, the large majority of FIRST alumni have entered higher education and are also pursuing interests in science and technology with much greater frequency than is the case for college-going students as a whole. At the same time, FIRST alumni also appear more likely to become involved in their community as volunteers (presumably reflecting FIRST's support for involvement in community service) and to identify community involvement as an important value. On the whole, these positive outcomes from FIRST are evident both in comparisons to broad national samples of college-aged young people and when the comparison is made to a more carefully matched comparison group of students with similar demographic and academic backgrounds.

The first part of this chapter examines a variety of educational and career-related outcomes for FIRST participants with comparisons, where possible, to national averages for all students drawn from Census data and the Department of Education's Beginning Postsecondary Student survey. The second part of the chapter examines the differences between FIRST participants and the matched comparison group of similar students created from the BPS data.

COLLEGE-GOING

Among those responding to the FRC survey, almost all (99%) reported graduating from high school, and the large majority (89%) went on to college. At the time of the survey, 79% were still in college, with most of the remaining respondents reporting that they were employed. Less than 7% of those who attended college indicated that they had dropped out. Only 5.5% of all of the FIRST alumni in the survey reported being unemployed at the time of the survey (Table 4-1).

Of those FIRST alumni who attended college, the large majority (86%) attended four-year institutions, and a similar proportion had attended college or were currently attending college on a full-time basis.

National data from the U.S. Census Bureau suggests that the rates of college-going are substantially higher for FIRST alumni than for recent high school graduates as a whole. Nationally, 65% of recent high school graduates were enrolled in college, compared to 79% of FIRST alumni.[14] Comparisons with national benchmarks on attendance at four-year colleges and full-time attendance are more difficult to make.[15] However, as discussed later, FIRST alumni were more likely to attend college full time, but not more likely to attend a four-year college, than the students in the matched comparison group.

Table 4-1: High School Graduation and College-Going, All FRC Respondents

Characteristic	N	Percent
Graduated high school	167	99.4%
Current Status		
Currently attending college	130	78.8%
Currently Employed	19	11.5%
Currently Unemployed	9	5.5%
Ever attended college	149	88.7%
College Experience		
Attended 2-year college	20	13.6%
Attended 4-year college	127	86.4%
Attended full-time	127	86.4%
Attended mix of full and part-time	14	9.5%
Attended part-time	6	4.1%

Note: Based on FRC survey data. N=173. Percentages are based on valid (i.e., non-missing) responses for each item.

[14] National data are from the U.S. Census, Current Population Survey, Table 13, "Enrollment and Employment Status of Recent High School Graduates 16 to 24 Years Old, by Type of School, Attainment Level for People Not Enrolled, Sex, Race, and Hispanic Origin," October 2002.

[15] The comparison to national Census data for attendance at 4-year colleges and full-time college cannot be made here because the Census data represents a point in time, while the FRC survey data provides for a cumulative measure covering all of the respondent's time in college – in effect, the difference between asking whether you are in a 4-year college now *versus* did you attend one at any point over the past four years. The comparison with the BPS data used for the matched comparison group is more appropriate.

These relatively high levels of college-going apply across the board to both men and women and across racial and ethnic groups. While there are some differences between groups (African-American alumni report a substantially lower college-going rate and a higher unemployment rate than other groups), each of the groups represented in the study are attending college at a substantially higher rate than the national average (Table 4-2).

Table 4-2: High School Graduation and College-Going, FRC Participants by Race and Gender and National Averages

Characteristic	Male	Female	African-American	Asian/ Pacific	Hispanic/ Latino	White
FRC Participants						
Graduated high school	99.0%	100.0%	100.0%	100.0%	100.0%	98.6%
Currently attending college	80.2%	77.3%	67.9%	84.6%	77.8%	80.6%
Employed	8.2%	14.7%	14.3%	7.4%	16.7%	11.0%
Unemployed	6.2%	4.4%	17.9%	0.0%	0.0%	0.0%
Ever attended college	87.6%	91.2%	78.6%	96.3%	94.4%	89.0%
Attended 2-year college	14.5%	11.3%	13.6%	11.5%	18.8%	13.2%
Attended 4-year college	85.5%	88.7%	86.4%	88.5%	81.3%	87.7%
Attended full-time	86.7%	85.5%	86.4%	96.0%	81.3%	84.6%
Attended mix of full and part-time	8.4%	11.3%	9.1%	0.0%	12.5%	10.8%
Attended part-time	4.8%	3.2%	4.5%	4.0%	6.3%	4.6%
National Averages (Census)						
College-Going (Currently attending college) among recent graduates	62.1%	68.4%	58.7%	65.2%	53.5%	66.7%

Note: FRC data from the FRC survey. National data are from the U.S. Census, Current Population Survey, Table 13. Enrollment and Employment Status of Recent High School Graduates 16 to 24 Years Old, by Type of School, Attainment Level for People Not Enrolled, Sex, Race, and Hispanic Origin: October 2002.

COURSES, INTERNSHIPS, AND FINANCIAL SUPPORT

Once in college, a substantial proportion of FIRST alumni took courses and participated in jobs and internships related to science, math and technology. Overall, nearly 90% of the FIRST team members took mathematics courses while in college and 78% took at least one science class (Table 4-3). More striking, however, is the fact that 51% of the FIRST alumni took at least one engineering class. While math and science are often part of the core curriculum at many colleges and universities, engineering classes are not. As such, the high degree of involvement in engineering classes is notable.

Nearly 60% of FIRST alumni also had at least one science or technology-related work experience, either as an intern, in an apprenticeship program, or through a part-time or summer job. A substantially smaller percentage (13%) received grants or scholarships related to science or engineering. National comparison figures are not available on the frequency of science-related internships or grants. However, as is discussed later, FRC alumni were substantially more likely to have an internship of any kind in their freshman year than matched comparison students, though they were substantially less likely to report receiving scholarships or grants.

Table 4-3: College Courses, Internships, and Support

Characteristic	N	Percent
College Courses Taken (At least one course in the following subjects)		
Mathematics	129	86.6%
Science	116	77.9%
Engineering	76	51.0%
Computer Science	71	47.7%
Internships, Jobs and Grants/Scholarships		
One or more science/technology internship, apprenticeship or job (summer or part-time) in college	86	57.7%
One or more non-science internship, apprenticeship, or job in college	79	53.0%
Had one or more Math, Science, Computer or Engineering Grant or Scholarship	19	12.8%
Had any type of grant or scholarship	98	65.8%

Note: Based on FRC survey data for those who attended college. N=149. Percentages are based on valid (i.e., non-missing) responses for each item.

As was the case for college-going generally, the involvement in math and science-related courses, internships, and grants was also relatively evenly spread across racial and ethnic groups and among both men and women (Table 4-4). In this instance, women and minorities were as likely (and in some cases more likely) to take math and science classes as men and white students; however, both women and minority students took engineering classes at a lower (though still substantial) rate. Interestingly, women were equally likely to have math or science-related scholarships, and women were substantially more likely to receive a scholarship or grant of any kind (math/science and others combined).

Table 4-4: College Courses, Internships, and Support by Race and Gender

Characteristic	Male	Female	African-American	Asian/ Pacific	Hispanic/ Latino	White
College Courses Taken (At least one course in the following subjects)						
Mathematics	85.9%	87.1%	81.8%	88.5%	82.4%	90.8%
Science	78.8%	75.8%	77.3%	73.1%	64.7%	84.6%
Computer Science	52.9%	40.3%	36.4%	50.0%	29.4%	55.4%
Engineering	60.0%	40.3%	45.5%	38.5%	52.9%	60.0%
Internships, Jobs and Grants/Scholarships						
One or more science/technology internship, apprenticeship or job (summer or part-time) in college	55.3%	59.7%	63.6%	57.7%	29.4%	63.1%
One or more non-science internship, apprenticeship, or job in college	47.1%	61.3%	59.1%	42.3%	47.1%	53.8%
Had one or more Math, Science, Computer or Engineering Grant or Scholarship	12.9%	12.9%	13.6%	0.0%	11.8%	18.5%
Had any type of grant or scholarship	58.8%	75.8%	72.7%	61.5%	52.9%	69.2%

Note: Based on FRC survey data for those who attended college. N=149. Percentages are based on valid (i.e., non-missing) responses for each item.

COLLEGE MAJORS

Perhaps the strongest indicator of the impact of FIRST can be found in the choice of college major by FIRST alumni (Table 4-5). Of the 137 FIRST team members who provided information on their college major (including both current students and those who had graduated before the survey), ***41%*** reported that they had selected Engineering as their major course of study. Another 11% had majored in Computer/Information Science, with Business Management as the other major in the top three (13%). Based on the summary data for all students in the national Beginning Postsecondary Student survey, FIRST alumni were nearly ***seven times*** as likely to become Engineering majors as the average college student nationally (41% vs. 6% nationally). FIRST alumni were also roughly twice as likely to enroll as computer science majors (11% vs. 5% nationally).[16] As discussed later in the chapter, while the differences were not as large, FRC were also significantly more likely to become science and engineering majors as were the students in the more targeted, matched comparison group.

Table 4-5: College Major

College Major	N	Percent
Engineering	56	40.9%
Business Management	18	13.1%
Computer/Information Science	15	10.9%
Social Sciences	11	8.0%
Health	9	6.6%
Other Professional	9	6.6%
Humanities	6	4.4%
Education	5	3.6%
Life Sciences	4	2.9%
Physical Sciences	3	2.2%
Vocational/Technical	1	0.7%

Note: Based on FRC survey data for those reporting college major. N=137.

As is the case with all of these results, it is important to recognize that there may be a degree of selection bias – that FIRST participants were already interested in science and technology or engineering and joined the program because of it. However, interviews with program participants and team leaders over the course of the year, as well as the responses to the open-ended questions on the survey, suggest that this is not necessarily true and/or that student interests were much less focused at the time they joined the program.

Issues of selection bias aside, what is clear from the survey data is that a high proportion of FIRST participants followed their interest in science and technology into college and into their choice of college majors. At the very least, it seems likely that FIRST helps to nurture, reinforce and focus the interest in science and technology to the extent that it is already present when young people join the program, and it seems like that it helps spark such interests among students who did not have a strong interest when they joined.

[16] National data cited here are from the U.S. Department of Education, Beginning Postsecondary Survey (1996-2001). Note, the figures presented in this section of the chapter refer to national averages (i.e., the average of all college students in the BPS data set. Comparisons to the matched sample of students taken from the BPS dataset are discussed later in the chapter.

While women and minorities generally pursue Engineering as a major less frequently than male FIRST alumni and white students, a substantial proportion of female and minority FIRST alumni (well above the national average) did study Engineering in college (Table 4-6). Overall, nearly 33% of the women in the study selected Engineering as a major (roughly fifteen times the national average of 2.1% for female college students nationally), as well as 36% of the Asian students in the sample and 47% of the Hispanic alumni in the study. African-American alumni were least likely to enroll in Engineering as a major, but were substantially more likely to choose Computer Sciences.

Table 4-6: College Major by Race and Gender

College Major	Male	Female	African-American	Asian/ Pacific	Hispanic/ Latino	White
Engineering	48.1%	32.8%	27.3%	36.0%	46.7%	44.1%
Business Management	6.5%	22.4%	4.5%	28.0%	6.7%	13.6%
Computer/Information Science	18.2%	1.7%	18.2%	4.0%	13.3%	10.2%
Social Sciences	6.5%	10.3%	0.0%	4.0%	6.7%	11.9%
Health	1.3%	13.8%	9.1%	16.0%	0.0%	3.4%
Other Professional	6.5%	6.9%	18.2%	0.0%	13.3%	3.4%
Humanities	5.2%	3.4%	0.0%	8.0%	13.3%	1.7%
Education	3.9%	1.7%	13.6%	0.0%	0.0%	3.4%
Life Sciences	1.3%	5.2%	4.5%	0.0%	0.0%	5.1%
Physical Sciences	1.3%	1.7%	4.5%	4.0%	0.0%	1.7%
Vocational/Technical	1.3%	0.0%	0.0%	0.0%	0.0%	1.7%
National Average - Engineering	12.7%	2.1%	5.3%	8.6%	6.3%	6.7%

Note: FRC data from the FRC survey. National averages are based on data for a national sample of approximately 12,000 students in the U.S. Department of Education, Beginning Postsecondary Survey dataset (1996-2001).

EDUCATIONAL ASPIRATIONS

FIRST alumni also evidenced a higher level of educational aspirations compared to those of college students nationally. When asked about the highest level of education they wanted to achieve, roughly 78% of the FIRST alumni reported that they expected to achieve a post-graduate degree: either a master's degree (47%) or another terminal degree such as a Ph.D., MD, or MBA (32%). Most of the remaining alumni (17%) expected to complete their education with a Bachelor's degree. Only 2 participants in the study (1.4%) reported that they did not expect to get any kind of degree or certificate (Table 4-7).

These figures are substantially higher than the national averages. Among the students in the national BPS sample, 60% aspired to completing a Master's degree or higher, and 4.4% reported that they did not expect to receive any kind of degree. While self-selection may again be an issue, the data suggest the graduates of the FIRST program entered college with a substantially higher set of educational expectations than the average college student across the nation. The fact that most of the students in the FRC sample came from schools that were generally considered "underserved" makes the results all the more notable.

Table 4-7: Educational Aspirations Among FRC Respondents

Educational Aspirations	N	Percent
No degree or certificate	2	1.4%
Certificate	3	2.0%
Associate's Degree	1	0.7%
Bachelor's Degree	25	16.9%
Post-Baccalaureate certificate	1	0.7%
Master's Degree (MA/MS)	69	46.6%
Other Graduate Degree (Ph.D., MBA, MD, etc.)	47	31.8%

Note: Based on FRC survey data for those who attended college. N=149. Percentages are based on valid (i.e., non-missing) responses for each item.

RESULTS FROM THE MATCHED SAMPLE

To what extent do the strong, positive outcomes for FRC participants stand up when FIRST alumni are compared to a group of students with similar demographic and academic backgrounds? The answer is that in almost every case, FIRST participants continued to show significantly better education, career, and developmental outcomes than the matched comparison students drawn from the BPS dataset.

Table 4-8 shows the results from the comparisons between the FRC participants and the matched comparison group on a number of education, career, and developmental outcome. As noted in Chapter One, this analysis compares the outcomes reported by FRC participants to those of a group of students from the BPS dataset who were carefully matched in terms of demographic characteristics (race, gender, parents' education, and socioeconomic characteristics of their high school) and in terms of high school academic background, including involvement in Math and Science (honors courses taken, math and science courses, etc.). Altogether, 147 FRC alumni and an equal number of comparison students were included in this part of the analysis. While the matching process does not control for possible differences in motivation or other unmeasured background characteristics, it does provide for a much more targeted and convincing comparison than those with the general population of college students.

The results are striking. On 16 of the 21 outcome measures used for this analysis, FRC participants showed outcomes that were significantly better than the comparison group; comparison students did better on only two measures (both related to receipt of grants and scholarships), and three measures showed no significant difference.

In terms of educational outcomes, FRC alumni were:

- Significantly more likely to attend college on a full-time basis than comparison students (88% vs. 53%);
- Nearly two times as likely to major in a science or engineering field (55% vs. 28%) and more than three times as likely to have majored specifically in engineering (41% vs. 13%);
- Roughly 10 times as likely to have had an apprenticeship, internship, or co-op job in their freshman year (27% vs. 2.7%); and
- Significantly more likely to expect to achieve a postgraduate degree (Master's degree or higher: 77% vs. 69%).

Table 4-8: FRC and Matched Comparison Group Results for Selected Education and Career Outcomes

	N*	Percentage of FIRST participants	Percentage of matched BPS cases	Difference**	Significance***
Attended 4-year college	252	86.5%	90.5%	-4.0%	
Attended college full-time	218	88.1%	53.2%	+34.9%	+++
Majored in a science/engineering field	202	54.5%	27.7%	+26.8%	+++
Majored in engineering	202	40.6%	12.9%	+27.7%	+++
Had internship, apprenticeship, coop job freshman year	294	26.5%	2.7%	+23.8%	+++
Had at least one grant/scholarship of any type	294	60.5%	79.6%	-19.1%	– – –
Received grant/scholarship freshman year	294	56.5%	69.4%	-12.9%	– –
Expect to achieve Masters degree or higher	242	76.9%	62.8%	+14.1%	++
Job expectations					
Engineering	102	31.4%	7.8%	+23.6%	+++
Science/Technical	102	45.1%	19.6%	+25.5%	+++
Females					
Majored in a science/engineering field	92	41.3%	21.7%	+19.6%	+
Majored in engineering	92	32.6%	8.7%	+23.9%	+++
Non-whites					
Majored in a science/engineering field	108	50.0%	33.3%	+16.7%	
Majored in engineering	108	31.5%	13.0%	+18.5%	++

Note: *Number is equally divided between FIRST and BPS cases. **FIRST percentage minus BPS percentages. ***Plus signs (+) indicate a positive difference; minus signs (–) indicate a negative difference. The number of pluses or minuses indicates significance level, i.e., three pluses (+++) indicate a positive difference that is significant at the .01 level; two (++) -- significant at the .05 level; and one (+) -- significant at the .10 level. Testing for significant differences was done using the Fisher's Exact Test.

In each cases, these differences were statistically significant, meaning that there was less than a 5% probability (and in some cases, a less than 1% probability) that the differences had occurred by chance.

The differences in declared science and engineering majors also applied to female and non-white FIRST participants. Women in FIRST were nearly twice as likely to major in a science or engineering field as those in the comparison group (41% vs. 22%) and nearly four times as likely to major specifically in engineering (33% vs. 9%). The differences for non-white FIRST participants were smaller, with non-white FRC participants roughly two and a half times more likely to have majored in engineering than non-white students in the comparison group. Non-white FRC participants were also more likely to major in the broader category of science/engineering fields, but these differences were not statistically significant.

In terms of career expectations, FRC alumni were also significantly more likely to expect to enter a science or engineering career. When asked what kind of job they expected to pursue after graduating college, FRC alumni were more than twice as likely as comparison students to identify a science or technology career (45% vs. 20%) and nearly four times as likely to specifically identify an engineering career (31% vs. 8%).

Finally, FIRST alumni were also significantly more likely to be involved in community service and to express a commitment to several positive goals and values than the members of the matched comparison group. In both cases, these outcomes suggest that FIRST's emphasis on the positive values of helping others and involvement in the community were having an effect on program participants. As Table 4-9 shows, FRC alumni were more than twice as likely to perform some type of volunteer service in the past year as were students in the matched comparison group, and were significantly more likely to provide some of the specific types of service that might be associated with FIRST team efforts: tutoring, other types of coaching or mentoring with young people (such as helping another team or a younger team), fundraising, and neighborhood improvement. In each of those specific categories of service, FRC alumni reported levels of volunteer service that were four to ten times as high as those of the comparison students.

Similarly, FIRST alumni were also significantly more likely to see several positive goals or values as "very important." As Table 4-9 shows, FIRST alumni were significantly more likely to want to be politically active as adults, to run their own businesses, and to be a leader in their communities. They were also somewhat more likely to want to be well-off financially, though the differences were only marginally significant (i.e., significant at the 0.1 level). The differences between FRC and comparison students were small and non-significant on two other goals: being successful in their careers and being an authority in their field.

Finally, the only outcomes in which the data indicate that FRC students did significantly worse than the comparison students were in receipt of grants and scholarships in their freshman year and across all four years of college. This is a somewhat surprising result given FIRST's active efforts to raise scholarship monies for FRC participants and the fact that 66% of FRC participants reported some form of grant or scholarship in college. However, it suggests that, as of the time these FRC students were going on to college (1999-2003), those efforts had not yet resulted in a relative advantage for FRC participants in grant or scholarship funding when compared to that for students with similar backgrounds.

There are a number of possible explanations for this, ranging from a potential bias in the comparison group (since the BPS sample drew heavily from federal financial aid data as a source, those involved in the study may have been more "aid savvy" than the FRC participants) to questions of whether FRC participants were sufficiently aware of scholarship opportunities or expected to attend the schools where it was available. In either case, the lower level of grant and scholarship receipt is an issue worth exploring further.

Table 4-9: FRC and Matched Comparison Group Results for Selected Developmental Outcomes

	N*	Percentage of FIRST participants	Percentage of matched BPS cases	Difference**	Significance***
Community service/volunteer related outcomes:					
Participated in any community service/volunteer work	232	70.7%	30.2%	+40.5%	+++
Tutoring or other education related work with kids	236	35.6%	8.5%	+27.1%	+++
Other work with kids(coaching, Scouts, big brother/big sister, etc.)	236	22.0%	5.1%	+16.9%	+++
Fundraising (other than political)	236	35.6%	3.4%	+32.2%	+++
Neighborhood Improvement	236	26.3%	2.5%	+23.8%	+++
Goals – those who consider it *very important* to:					
Be well off financially	240	70.8%	59.2%	+11.6%	+
Be very successful in their career	240	94.2%	90.0%	+3.8%	
Be a leader in their community	238	43.7%	28.6%	+15.1%	++
Be an authority in their field	238	53.8%	51.3%	+2.5%	
Run their own business	238	35.6%	24.4%	+11.2%	++
Influence the political structure/be politically active	238	22.9%	10.9%	+12.0%	+++

Note: *Number is equally divided between FIRST and BPS cases. **FIRST percentage minus BPS percentages. ***Plus signs (+) indicate a positive difference; minus signs (–) indicate a negative difference. The number of pluses or minuses indicates significance level, i.e., three pluses (+++) indicate a positive difference that is significant at the .01 level; two (++) -- significant at the .05 level; and one (+) -- significant at the .10 level. Testing for significant differences was done using the Fisher's Exact Test.

SUMMARY OF EDUCATION, CAREER, AND DEVELOPMENTAL OUTCOMES

Across the board, the data from the FRC survey indicates that FIRST alumni have gone on to college, pursued educational programs in science and engineering, and maintained a degree of active involvement in the community at higher rates than students nationally and/or than a carefully matched comparison group of students with similar demographic and academic backgrounds. Perhaps the most striking finding is that FIRST alumni have selected Engineering as a major in college at a rate that is roughly seven times the national average and more than three times that of students with similar backgrounds in math and science in high school. There are similar, substantial differences in college-going and college majors for both women and non-white students in FIRST as well, suggesting that the program is being successful in its goals of generating interest in engineering among groups traditionally under-represented in that field. In each case, the results from FIRST are particularly impressive given that the young people in the study were drawn from traditionally underserved schools in low income and urban communities.

When combined with the self-reported impacts on knowledge, skills and attitudes discussed in the previous section of the report, the results from the survey of FIRST alumni present a persuasive case that involvement in FIRST has a strong, positive impact on participating youth, including young women and minority students. While a more comprehensive longitudinal study

is needed to provide additional confirmation of FIRST's longer-term impacts, the data generated in this study present strong evidence that FIRST is meeting its goals of providing a positive and engaging developmental experience for young people and is succeeding in its efforts to increase the interest and involvement of participating youth in the fields of science and technology.

CHAPTER FIVE
INSTITUTIONAL CONTEXT FOR FIRST: IMPACTS ON PARTICIPATING SCHOOLS , TEACHERS, AND MENTORS

While the primary focus of the FRC evaluation is on the assessment of the participant impacts from the program, the study was also designed to begin to document the impacts of the program on other local stakeholders – participating schools, teachers, mentors, and the sponsoring organizations. To what extent did involvement in the FIRST Robotics Competition foster "spin-off" effects in the schools in terms of new courses, increased school spirit or community involvement? Did involvement in the program change the ways that teachers taught at the school? What benefits did mentors see in their involvement, and were there benefits to the companies that funded and/or provided technical support?

This chapter presents the findings on these questions based on site visits and telephone interviews conducted with team leaders, partners, school administrators and others in 10 schools in the New York and Detroit/Pontiac metropolitan areas. Table 5-1 provides a listing of the schools visited as part of the study. Brief profiles of the FRC programs are included in the Appendix.

Table 5-1: Site Visit Schools/Team

School	Location
Buena Vista High School	MI (Saginaw)
Pontiac Central High School	MI (Pontiac/Sterling Heights)
Hamtramck High School	MI (Detroit)
Osborn High School	MI (Detroit)
Cooley High School	MI (Detroit)
Golightly High School	MI (Detroit)
Pontiac Northern High School	MI (Pontiac)
Westinghouse High School	NYC (Brooklyn)
Morris High School	NYC (Bronx)
Washington Irving High School	NYC (Manhattan)
McKee Vocational Technical High School	NYC (Staten Island)
Brooklyn Tech High School	NYC (Brooklyn)

IMPACT ON THE SCHOOLS

While the major focus of FIRST is on the teams and participating students, one of the goals of the organization (often unstated) is to promote expanded and improved teaching of science and technology in the schools where FIRST teams are located and to have a positive impact on the school and school culture generally. In effect, the goal is for FIRST to both demonstrate that involvement in science and technology can be fun and interesting for students while also modeling new and effective ways of teaching and learning for schools.

Based on the meetings with team leaders and other school staff (teachers, guidance counselors, machinists, etc.), FIRST has had a positive impact on participating schools in a number of ways:

- Courses (creating new courses or introducing robotics elements into existing courses)
- Professional development of teachers (changing teaching styles and increasing teachers' knowledge of science, math, or technology concepts)
- School culture (creating a positive spirit in the school)
- School reputation and perception (improving the community's view of the school)

In other areas, however, impacts were more limited. Little to no impact was seen in new technology investments or business partnerships in the schools that expanded beyond direct involvement in the FIRST teams. Though a number of changes in curriculum did occur as a result of FRC, broader school-wide science and math curriculum reform or utilization of the partner institutions (mentors and sponsors) for school improvement beyond assisting FRC team leaders and team members has not occurred. However, as one principal we interviewed cautioned, "FIRST is not and should not be seen as the salve to all of the school's woes." Keeping that in mind, FRC did impact schools in important ways. The following sections will highlight these impacts.

Courses. Eight of the ten sites visited reported creating new courses or modifying existing ones at the schools as a result of their involvement in FIRST, in some cases introducing robotics elements into existing courses, and in others working to create new courses modeled after the FRC experience.

- Five schools reported incorporating robotics elements into existing courses.

- Three schools reported creating new courses. Two had them in the past, and one implemented a course for freshmen this year with the hope of expanding it into the other grade levels.

Some of the ways that schools have incorporated FRC into their classrooms included institutionalizing a robotics elective into the core curriculum; improvement of CAD instruction and introduction of AutoCAD and animation; and using robotics equipment as a supplement to lessons in existing science classes.

Professional development of teachers. Coaches were also asked if being involved with FRC had affected their teaching style (e.g., introduction of more hands-on and project-based learning) or helped to improve their knowledge of science, math, or technology concepts.

Coaches' responses ranged from little or no impact to incorporating some elements of FRC in their classes, with no clear pattern of change. It is important to note, however, that many coaches were using hands-on and project-based learning in the classes before their involvement in FRC, so that FIRST served more as a reflection of their existing teaching style and less of an opportunity to learn new methods.

Few coaches talked explicitly about increasing their own knowledge of science, math, or technology. However, many did talk about relying on the corporate mentors for expertise they themselves did not have, suggesting that there was an opportunity to strengthen their knowledge

base. A few coaches talked about an increased satisfaction in teaching as a result of FIRST because it provided an opportunity to gain more first-hand knowledge and have a greater ability to connect science and technology concepts to real-world applications.

The other area in which coaches identified an impact was in terms of the skills needed to plan and manage the FIRST team. As was the case with the team members, several of the coaches noted that they learned important planning, problem-solving, and project management skills, while another noted that FIRST allowed him to use skill sets with his team that he would not otherwise use in the classroom.

The overall message that we heard from the coaches was that FIRST contributed to the professional development of the coaches by allowing them to use a different set of skills, but that it had not led to a significant change in the teaching that took place in their classrooms.

School Culture and Reputation. The FIRST Robotics Competition most strongly affects those students directly involved in the program. However, most coaches also saw some impact on the school as a whole. These impacts were seen in two key areas: promotion of school spirit and improved reputation for the school in the community.

Perhaps the most common of the school impacts mentioned by FRC team leaders was that FIRST had helped to create a "positive spirit" in the school and served as something of which the school could be proud. School spirit was highlighted as an area of impact by most of the coaches' interviews. Commenting on how the school would be without FRC, one coach said: "[The school] would really be losing out because students wouldn't be excited."

Teams encouraged that sense of school spirit by using banners, bulletin boards, and trophy display cases around the school and by bringing students from the school to the tournaments. Other coaches worked to expand the scope of the team's influence by involving students beyond the team in fundraising, art projects, and creating the team website. One of the results, several coaches noted, was an increase in respect for team members within the school, with several coaches noting that team members had come to be revered in much the same way as the varsity athletes in the school.

In much the same vein, coaches also reported that the FRC team had helped change the community's perception of their school and, in doing so, created a means of attracting students to enroll. In one of the site visit schools, the coach commented that FRC had enabled his school to be "somebody" in their borough and in New York City as a whole. Another team leader attributed the increase in this year's incoming freshman class from 150 to 350 students to FRC's presence in the school. Publicity about team accomplishments in local media outlets had helped change the community's perception of the school and improve the school's reputation.

At the same time, the coach at another school pointed out the limits of that kind of community impact. As his school drew students from all over the city, it was hard to create the same kind of community ownership and awareness as might be the case in smaller, less urban communities. His comments suggest that the issues of school outreach and impact associated with FIRST may be very different for some urban schools than those in more suburban communities.

Taken together, the interviews with school coaches and school administrators point to a broad, but often modest impact from FIRST on the broader school community. While FRC has been seen as a source of community pride and involvement and the basis for new courses in several schools, it has not yet led to the establishment of broader curricular reforms or the expansion of partnerships with FRC sponsors to other areas of the school.

FIRST TEAMS AND THEIR MENTORS

One of the other goals of the FRC evaluation was to learn more about the role of the team mentors, including the extent to which involvement in FIRST was seen as having an impact on the mentors themselves or their institutions. In that context, the site visit discussions included interviews with mentors and discussions with team leaders about how mentors were involved in the program.

Use of mentors in FRC. Mentors played an important role in almost all of the teams that we visited. According to team leaders, teams need to assemble a group of individuals with a relatively wide range of skills. Shop, machine, programming and engineering skills are particularly critical. Of the teams interviewed, only one did not have any corporate/university mentors. All of the other teams used the skills and experience of outside mentors.

The roles that the mentors and the sponsoring organizations played varied widely from team to team. In general, mentors provided teams with technical instruction and guidance on the robot, but in some cases also helped team members with homework and college preparation and worked to develop positive relationships with the students on the team.

Most teams reported that mentors provided assistance to teams through a combination of topic-based workshops for team members and hands-on guidance with individual students, and that during build season, many of the mentors were at the school or company several times a week building the robot alongside team members.

Other sponsors, however, took additional steps. It was surprising how many of the corporate mentors in our sample were involved with multiple teams: *all* of the mentors we interviewed noted their company or university mentored multiple teams. Among the teams in our sample, it was much more common to find a large corporation sharing its knowledge and support with several teams than it was for a mentor to be working with just one school. This was particularly true of the Michigan teams, where there are large corporate supporters such as Delphi, GM and Ford. In one case in Michigan, one of the sponsoring corporations hosts workshops and invites area teams to attend. In another Michigan example, the sponsoring company allows multiple teams to use its workspace to build their robots. But even in NYC, where corporate support was more modest, at least three of the corporations/universities were mentoring multiple teams. Finally, a number of mentors have tried to branch out to new teams. For example, one mentor started an "adopt a rookie" initiative, where they walked new coaches through the process of forming a team and give them lessons about the program.

Training. None of the mentors we interviewed received any formal training specific to working with the FRC teams. Many mentors mentioned they had already had experience working with youth, and those who were FRC alumni themselves already had an understanding of the program. However, one mentor reported his fellow mentors are trained in company policies (i.e., guidelines for working with minors and working with those outside the company) and that mentors are expected to emphasize the company's engineering processes when working with the students, but, again, there is no specific training on how best to mentor an FRC team. Only two mentors thought that more formal training (e.g., a workshop in the fall similar to the leader training provided by FIRST's LEGO® League program) would be helpful. One mentor from a university will be introducing training for those who were not involved with FRC as high school students, which will consist of discussions of mentor roles and challenges, technical training, etc.

Alumni Mentors. Though most mentors were engineers from corporations, and one team received mentoring solely from university students, at least three teams were also being mentored by former FIRST team members who were not part of a corporate mentoring program. As with other mentors, these alumni devoted many hours per week to FIRST, but felt that the rewards were worth the time they invested. They stressed that they enjoyed the sense of connection they were able to maintain with the school and team because of their mentoring role, as well as the friendships they had made with people from all over the country. For at least one of the alumni mentors, there were also clear practical benefits. In that instance, the alumnus had decided to become a teacher. He liked the real-world application of FIRST and wanted to use the hands-on approach to learning in his own teaching. As a result, working with the FRC team helped him to work towards his own personal goals. There were other examples of alumni who kept in touch with their former teams through phone calls and emails, of an alumni who used his vacation time from work to attend an FRC event, and of alumni who pooled their money to donate to the team.

Impacts on Mentors. Both mentors and the coaches that were interviewed noted a variety of positive impacts on mentors as a result of their involvement in FIRST, including opportunities for career advancement, increased morale and job satisfaction, access to new hires, and a sense of satisfaction and connection to the students on the team.

Perhaps the most common impact is the development of relationships between the mentors and students, many of which were often maintained after the season was over. In one site, for example, team members who were mentored by college students continued to keep in touch after the school year was over. In another case, the team's corporate mentors lost their jobs when the company dissolved. The individual mentors continued to work with the team, however. As the coach said, "they really loved working with the kids."

Some mentors mentioned that they saw racial and other social barriers break down as teams got to know each other. Mentors who were not used to working with young people were soon made to feel like they were part of the family. This cross-exposure of students and adults from different locations and backgrounds was reported by mentors as being a particularly positive aspect of the program.

Mentors and team leaders alike noted that the FIRST experience also gave employees a chance to do something different and that they genuinely enjoyed the time they spent with students. Also speaking about increased morale, one mentor mentioned that FRC provides a "chance for engineers to be in a situation where their career choice is reaffirmed, but it's fun!"

Several mentors reported professional advances that they felt were due to the leadership role they played with FIRST teams. As a result of his work with FIRST, one mentor reported his CEO now knew who he was. He mentioned specific opportunities (i.e., promotions, speaking engagements, etc.) that he had been given that he felt were closely related to his work with FIRST.

In addition to the many positive impacts reported, some mentors did mention potentially negative impacts on their personal relationships and careers:

- Several mentors mentioned that it was often challenging to devote so much time to FRC and still have enough time to spend with their significant other. In describing his cadre of mentors, one mentor quipped he had "35 widows to FRC in the first month [of the build season]."

- Several mentors noted that, while they enjoyed the experience of impacting young adults, being involved with FRC had little to no impact on their own careers. In fact, one mentor commented that spending company time on FRC activities might have taken away from his work responsibilities.

Overall, though, most mentors spoke of the great personal satisfaction in mentoring the FRC team members, as well as the strengthening of skills and increased morale they experienced because of their involvement in the program.

Impacts on corporations. Based on our interviews with the mentors, FIRST appears to have had a limited impact on the sponsoring corporations' marketing, recruiting and hiring practices, with a few exceptions. Where changes have taken place, they have tended to be driven by individual engineers rather than having been integrated into company-wide policies.

- *Marketing.* Five mentors from three companies and one university discussed the limited, informal manner in which their institution markets involvement with FRC. Only one company includes its sponsorship of FRC teams in its annual report, but as the economy has suffered has tried not to highlight FRC in the report or on its website so as not to sour investor relations by spotlighting charitable donations. Other marketing efforts include an unsuccessful attempt to have car dealerships show a video about FRC, having FRC displays at some work events and creating a display on FRC that ran through last summer in a local museum. One mentor hoped that hiring FRC alumni might encourage the company to start marketing its sponsorship of FRC.

- *Recruiting and hiring.* Several corporate mentors mentioned that FIRST had played a role in who they hired for internships and summer programs as well as more permanent positions, with one noting he has recruited not only from his own teams but from teams he has seen at

competitions. Another noted that being an official sponsor of FRC has generated cold call requests for interviews. Mentors also mentioned that FIRST alumni often have a good work ethic and a better understanding of engineering and timeframes than other job candidates or new hires. Although the individual mentors might see FRC as good training on how to get the a job done quickly and right the first time, sponsoring companies as a whole have yet to recognize that FRC can serve as a pipeline for recruiting and hiring as there are no formal mechanisms in place.

- *Other impacts.* One mentor described how being involved with FRC has fostered "superb" community relations. He reported that his vice president told him the company has received more letters of appreciation and thanks from their FRC sponsorship than any other community project with which the company has been involved. Another mentor noted that, as an official sponsor of FRC, the company has benefited because a lot of its customers and suppliers are also involved with the program

Sustainability. Because many of the FRC teams are championed by a combination of only a few teachers and corporate/university mentors, we talked with several mentors about any steps they have taken to sustain their company's involvement in the program. Though they currently receive strong support, most mentors have not yet institutionalized FRC in their company (e.g., getting FRC supported through the company fund or other forms of stable support), though they are hoping to do so.

- Several mentors underscored the importance of having senior level backing in order to sustain their company's involvement with FRC. As one mentor noted, the two vice presidents at his company who originally championed FRC are now gone, but recruited replacements who would also support FRC. In giving advice on how to obtain this support, one mentor suggested having a senior executive from a company already involved with FRC talk with senior staff at a company considering involvement in order to provide some credibility.

- One mentor noted that he and his colleague who head the mentor group are not very skilled in public relations, but if they were to get that kind of help, FRC would have more exposure within the company. FIRST might consider offering teams marketing tips for mentors to use within their company to gain broader support.

- One university mentor took a very different approach, organizing a mentoring group that is entirely student-run. Although they have had challenges in becoming a club officially recognized by the university (which would give them university funding and space for their mentorship activities), he is developing a plan to expand the university-high school partnership model throughout New York City. This model might be particularly attractive for those teams unable to obtain corporate mentors.

Differences Between Michigan and New York Sponsors. One of the other critical findings from the site visits (discussed in the challenges section below) was the degree to which the corporate and mentor relationships differed between the two regions where the site visits took place. In Michigan, where the large automotive and automotive supply firms became involved in FIRST

early on, teams often received a level of support and access to equipment and funds that was much greater than in the case of the New York teams. As a result, for example, Michigan team members were more likely to have access to higher quality workshops and to be able to attend multiple tournaments and the Nationals during their time on the team. New York teams generally struggled more to find locations to build the robots or the technical and engineering expertise needed by the team. Another difference is that in New York, the FRC and FLL seasons are the same (whereas the norm is for the seasons not to overlap). One mentor noted that this makes it quite difficult for mentors and students to be involved with both FRC and FLL.

At the same time, there were also strong similarities between the two sets of teams, based on the fact that all were operating in urban and low income environments. Both sets of teams had to work to maintain their relationships with the sponsoring organizations (even in Michigan, company support could disappear with a change in leadership or personnel); all had to deal with issues of funding, finding space to meet, and coach and mentor burnout. These kinds of issues are highlighted in the Challenges and Strategies section that follows.

CHALLENGES AND STRATEGIES

FRC coaches and mentors invest a lot of time and energy in making the program experience successful and meaningful for their team members. One of the goals of this study was to ascertain whether there are challenges unique to working in and with underserved schools. We talked with coaches, mentors, and team members about what kinds of barriers and challenges they have faced. What follows is a brief listing of these kinds of challenges and some strategies coaches and mentors have used to try to overcome these obstacles.

- *1st Year Challenges*. Only three coaches talked about challenges unique to their first year of coaching, but those challenges were significant: figuring out how to organize and run the team, determining how to ensure a student-directed program; and assembling a sufficient coaching group. Several mentors discussed a learning curve associated with letting the team members do most of the work, especially in terms of designing and building the robot. They found they did most of the work their first year, but over time realized how to allow the students to take charge.

- *Meeting Space.* Access to the space and equipment to conduct team meetings and build the robot varied. Schools that had a technical or vocational focus, either currently or at some point in their history, had an advantage over comprehensive high schools in terms of the amount and type of tools and equipment that were readily available to students. Most teams had a room in which they held team meetings and tools to work on the robot, but needed to go off-site (relying on their corporate or university partners) for heavy machinery. Several coaches also noted the importance of securing the support of the school administration and custodial and security staff to keep the school open for late-night or weekend meetings.

- *Transportation and safety.* At least half of the teams discussed transportation challenges and other safety issues. During the competition season, many teams work on their robot until late at night (some report staying as late as midnight), and safety and transportation therefore become challenges for the teams. Some coaches reported that they and their fellow teachers

frequently must drive students home, a practice not generally sanctioned by school districts. One mentor also described transportation difficulties as being a "huge" challenge.

- *Financial Challenges*. Obtaining and maintaining sources of funding was overwhelmingly reported to be the primary challenge in doing FRC, and travel was reported to be the biggest cost. The NYC teams we interviewed had more difficulties in this area than those in Michigan, who typically were approached by large corporate funders to start their teams. Teams tended to rely on some combination of several sources of funding: corporate donations; district contributions; fundraising activities and raffles; and, less frequently, small donations from parents and alumni. Those teams that are not as successful in fundraising may have a different experience in FRC: they often work with a set of inferior tools, equipment and materials and cannot afford to go to as many tournaments (including Nationals) or bring as many team members to each. Challenges in fundraising contribute to the exhaustion felt by some coaches.

- *Burnout.* Because of the intensity of the program, avoiding burnout is a challenge for many coaches. Coaches suggested different strategies including dividing the workload across several coaches and students as well as "over-organizing" to ensure efficiency.

- *Working with corporations.* Though relations with individual employees were generally regarded as excellent, several coaches did report challenges that they had encountered in working with corporations, such as little team control over the budget and pressure to win on the mentors from their CEOs.

- *Recruiting mentors.* Overall, the teams located in New York City had a more difficult time recruiting corporate sponsors and mentors than did the teams based in Michigan. There was a pronounced difference in the start-up stories of the teams in each location. All five of the Michigan schools we interviewed were approached by large corporations and were asked to participate with them in FIRST and generally provided substantial funding. While four of the five NYC teams did have corporate support, the support was much less extensive than that described by teams in Michigan. All of the NYC teams had worked hard to recruit the corporations, and only one was simply approached by funders, as was more often the case in Michigan. Though the stories of the New York employees indicated that they were just as committed to helping students as were the employees in Michigan, they did not bring with them the massive infrastructure of support that was commonplace among the Michigan corporations. Several coaches, from both NYC and Michigan, noted some difficulty in adjusting to the turnover of some mentors from year to year (e.g., due to being transferred by the company to another city).

- *Recruiting teachers.* Recruiting teachers to work with the team was viewed as an important ingredient to manage the workload and reduce burnout over time. Most of the coaches that we interviewed worked with a small team of four to five other teachers or school personnel (i.e., guidance counselors, etc.), but a few had some difficulty building this support or finding the "right mix" of talent. We also heard from two coaches that having a program in the school, such as FRC, that receives so much attention and funding can cause some resentment from other teachers not involved in the program.

- *School administration support.* While school officials were generally in favor of FRC, the level of support they provided varied. In most cases, teams were able to obtain the resources they needed, but their responses indicated some ambivalence on the part of some school administrators, with only one team really having a difficult time securing any kind of support from officials. It may be that raising the awareness of how FRC can benefit schools might enable teams to secure more extensive support from their principals and other school administrators.

- *District Level Support.* The NYC teams that we interviewed indicated that no financial support from the NY Department of Education was available due to cost cutting measures. Though school districts in MI were described as "really hurting," suffering from layoffs, controversy and lawsuits, we heard positive statements that indicated fairly adequate support for FIRST programs (e.g., funding for team uniforms, travel, paying for substitute teachers, and providing some stipends).

- *Parent Support.* Most of the teams indicated that they have had low levels of parent involvement, but did not necessarily find this to pose a major problem. We often heard that because most parents are working, they do not have time to volunteer. They also do not have the financial resources or technical skills to donate to the team as might be the case for teams in more affluent communities. Only two teams reported that they did have fairly strong parent support.

Challenges of working with underserved schools. In interviews specifically with the mentors, several additional challenges associated with corporate involvement in underserved schools were noted.

- *Turnover of school administrators.* Administrative turnover often occurs in urban school systems, and is an issue that FIRST should consider when expanding into more underserved areas. As one mentor from Detroit noted, because there is frequent turnover of Detroit principals, each year he and his fellow mentors must explain FRC to them and get their buy-in.

- *Attendance of* team *members at meetings.* A few mentors remarked that some students find they cannot attend team meetings because they must work after school or baby-sit their siblings. Others have transportation problems getting to and from the meetings. These points was also echoed by some coaches. Despite this challenge, one mentor told us working with an underserved student population was "well worth it."

- *Working with students from underserved areas.* Though mentors overwhelmingly talked about their positive experience in mentoring FRC team members, some did note challenges in determining how to best accommodate students with behavioral problems, special needs and difficult personal lives, as well as those students who "fail off" teams, who are not used to being able to lead a project themselves, or who hesitate to socialize with students from more affluent suburban teams. However, most mentors found students easy to work with and felt that their working relationships were mutually rewarding. It is important also to note that

these challenges are not all unique to underserved teams, but these teams might have greater difficulties or need additional guidance in overcoming these challenges.

- *Working with school staff.* The main challenges mentors experience in working with school staff centered around three issues: teacher participation; communication; and team operation philosophies. More specifically, one mentor working with Detroit schools noted that his company lost several teams this year: the high schools backed out because there were no funds available to pay stipends for the teachers working with the teams, or because they did not want to allow students to take time off to travel to FRC competitions. In addition, another engineer noted that getting adequate teacher participation has not been easy because of the many other commitments teachers have and recommends using software such as Lotus Notes to better manage communication between mentors and school staff. Finally, a head mentor reported his mentors have clashed with some teachers and principals who are involved with FRC because these school staff had a differing philosophy of how the team should operate (e.g., the school staff wanted more adult intervention in building the robot so as to have a winning team, whereas the mentors felt the students ought to do the work).

Despite the challenges associated with underserved schools, mentors enjoyed working with the young people on FIRST teams and were committed to working in urban and low income communities, and many even planned to expand their involvement with new teams. Commenting on why his company picked Detroit as a city in which to sponsor teams, one mentor said, "Most of the students have had zero exposure to things mechanical because Detroit had shut down centralized vocational schools and there are no shops in schools anymore." His company hopes to receive a return on their investment in these students: they see their FRC team members as potentially being strong future job applicants at their company.

ADVICE FROM THE FIELD

Teachers and mentors were asked what kinds of advice they might have for new teams, or for existing teams that were still struggling. Coaches provided tips on teamwork, setting up an adequate workspace, and raising the funds needed to run the team, while much of the advice given by the mentors focused on how to work successfully with schools and school districts, recruit employees to become FRC mentors, and further integrate FRC into their company. Below is some of the feedback that could be useful for other teams.

Advice for School Coaching Staff

<u>Teamwork</u>

- Seek help and continue to ask questions even after your rookie years.
- Recruit a team of several teachers to reduce workload and coach burnout. They need to be dedicated, willing to spend the time, and willing to learn.
- Team up with nearby schools to share resources (i.e., equipment, time, skills, people, ideas, etc.).

Work Space and Equipment

- Establish a work area and put aside funds for buying and replacing tools.
- Teaching students to take care of the tools and equipment reduces costs of replacing them.
- Establishing a common build center can allow more teams to participate in FRC and create opportunities for networking among teams.

Fundraising

- Learn how to promote yourself. Consider seeking the expertise of a mentor on publicity materials and promotion.
- Be creative about your sponsorships. Ask anyone you know to assist your team in some way, even if small (e.g., ask the local pizza parlor to provide pizza instead of money).
- Consider fundraisers that are easy to manage and do not require storage space (i.e., raffle tickets).

Mentor Advice

Working with Schools and School Districts

- Think creatively about how to channel money toward the team (i.e., have the corporate sponsor provide a cash card and handle travel costs; set up a non-profit for the team, etc.). Be aware that school districts can have administrative restrictions that funnel money away from the team.
- It is crucial to have the support of senior administration, such as principals and superintendents. Without their support, students and teachers have difficulty getting time off from their classes, securing space, etc. Scholarships are one way to attract the support of school administrators.

Recruiting Mentors

- Mentoring skills develop over time. For example, it often takes some time for mentors to learn to let students build the robot themselves.
- Employees can be recruited through new hire or training programs.
- Inviting engineers who are women and/or ethnic minorities may have more potential for increasing diversity than a general announcement to the entire corporate community.

Sustaining Broader Corporate Impact

- Look to the Human Resources or Community Relations Departments when considering ways to institutionalize and integrate into the company.
- Channel information on students and alumni to decision-makers on hiring and internships.

SUMMARY OF INSTITUTIONAL CONTEXTS

The broad message to emerge from the site visits and interview is that FIRST does contribute to the life and culture of the participating schools, teachers and mentors: fostering school spirit, promoting school reputations in the community; supporting the development of new curriculum or courses, and providing a sense of satisfaction for many of the adults involved in the program. At the same time, most of the institutional impacts from FIRST still occur on an individual, often

ad hoc basis, as individual teachers push for a new course or an engineer at a sponsoring firm begins to recruit FIRST alumni for the firm. At this point in time, there is little evidence that FIRST leads (or has explicitly intended to lead) to broad, institution-wide changes in policy or curriculum at participating schools, or to the establishment of comprehensive, institution-wide partnerships between schools and sponsoring firms.

While there is little evidence of systemic change associated with FIRST, the site visits have helped to identify an array of challenges and advice from the field that should be of value to FRC staff as they continue to refine and grow the program. While there are few "magic bullet" answers available for how best to establish and sustain a FIRST team in the types of schools visited for this study, FIRST can begin to look at how to incorporate some of the challenges and advice identified here into training materials for teachers and mentors or other forms of support as the network of FRC teams continues to grow.

CHAPTER SIX
CONCLUSION

The FIRST Robotics Competition evaluation was designed to provide FIRST with its first systematic study of the longer-term impacts of program participation on FRC participants and to provide an initial assessment of the impacts of FIRST on participating schools and sponsoring institutions. While the study is limited in some ways by its use of a retrospective approach, the results are still powerful and strongly positive.

The major finding from the study, based on the data from the FRC survey, is that the FIRST Robotics Competition does appear to be successful in meeting its goals of promoting a positive academic trajectory for its students and a sustained interest in science and technology-related education and careers. Nearly 90% of the FRC alumni in the study attended college, a rate substantially above the national average, and the higher than average college-going rates were evident for women and minorities in the program as well as for the sample as a whole. Once at college, FRC students were also much more likely than non-participants to pursue courses and careers in science and technology-related fields. One of the most striking findings from the study is the fact that 41% of the team members who responded listed Engineering as their primary major – a figure nearly seven times the national average.

When compared with a matched sample of students with similar demographic and academic backgrounds, FIRST participants continued to show significantly greater participation in science and technology in college, with FRC participants more than three times as likely to be majoring in Engineering and to expect to pursue an Engineering career after graduation. FIRST alumni were also significantly more likely to be attending college full-time, to have an internship or co-op job in their freshman year of college, and to expect to attain some form of post-graduate degree. While the study cannot control for the initial motivation of the FRC students (i.e., the degree to which they already had science or technology careers in mind at entry into the program), the use of a matched comparison group of students with similar backgrounds in science in high school lends credence to the conclusion that FIRST did make a difference in students' choice of college careers and that, without FIRST, they would have been less likely to go into a science or technology-related field.

Based on the data from the FRC survey, FIRST also had a wide range of additional impacts on participant attitudes, knowledge and skills. In assessing the program's impact on themselves, FRC participants pointed to an increased interest in science and technology, a positive sense of belonging and increased self-confidence, and the acquisition of a variety of practical problem-solving, planning, and communications skills. For most of those involved in the program, FIRST was one of the most important influences on their lives in high school, and the data suggest that the influence of the program continued in the post-high school years. Taken together, the participant self-assessments and the post-program outcomes data make a strong case that FIRST did have the kinds of education, career, and developmental impacts that the program had intended.

While the impacts on individual participants were strong, the impact of FIRST on local schools is likely more modest. FIRST has clearly helped participating schools in introducing new course subjects (robotics) and in fostering a positive school spirit. But in many cases that has been the limit of the school impact. If greater impacts are desired by the program, a more deliberate, school-focused strategy may be needed.

Finally, as the final section of the report notes, there are also a variety of challenges still to be met as FIRST programs move into additional schools and, in particular, to schools in underserved communities. While there are no "magic bullet" solutions, practitioners in the schools visited for the study offer a variety of practical suggestions that can help to inform future training and support efforts as FIRST continues to grow.

RECOMMENDATIONS

The principal findings of this study provide strong support for the continued growth and expansion of the FIRST robotics programs, particularly into communities serving low income and minority youth. Based on the findings from this study, FIRST can successfully engage young people in activities that promote a longer-term interest in science and technology and that appear to contribute to positive educational, career, and developmental outcomes.

At the same time, as the program moves forward, it will continue to be important to continue to document the effectiveness of the program and to build a broader base of evidence for the program's impacts. To that end, we recommend building on this retrospective study with a broader longitudinal effort that can better control for questions of initial motivation of FIRST participants and can also examine the impacts of the program among a broader group of participants. Similarly, as has been discussed with FIRST staff over the course of the study, we strongly recommend the development of a participant registration process for FRC that would make it easier to keep in touch with FIRST alumni on a regular basis and to track the longer-term career trajectories of former participants.

APPENDICES

Using Propensity Scores to Create a Matched Comparison Group

FRC Survey

Profiles of Site Visit Schools

Using Propensity Scores to Create a Matched Comparison Group

This study made use of "propensity score matching" to draw a sample of young people similar to the group of FIRST graduates responding to the retrospective survey. Propensity score matching is a technique that that calculates a propensity – i.e., the predicted probability – of being part of a treatment group (FIRST graduates in this case) based on individual characteristics of treatment and potential comparison group members. Each propensity score for a treatment group member is then compared to propensity scores for potential comparison group members in a search for the closest possible match.[1]

The steps involved in conducting the propensity score matching were as follows:

1. Choosing the individual characteristics to be used in matching FIRST graduates and individuals in the pool of potential comparison group members, i.e., respondents to the Beginning Postsecondary Student Survey. We examined individual characteristics in two categories: core demographic variables and high school academic background variables. Core demographic variables included gender, age, race, parents' education, and free lunch status of the school (a proxy for socioeconomic status). High school background variables included taking honors math, taking honors science, grade point average, and whether or not an individual took various math and science courses. Some variables – most prominently SAT/ACT scores – were not included initially because of a large number of missing values.

2. Tabulations of FIRST data for these variables indicated that 12 individuals had missing information on some or all of these individual characteristics. These cases were dropped from the matching procedures because it would have been impossible to match them with potential comparison group members in any meaningful way. This reduced the FIRST group to 156 individuals.

3. Propensity scores for FIRST group and potential comparison group members were calculated using logistic regression. That is, the demographic and academic variables were regressed against a variable indicating treatment and control group to generate a variable predicting the probability of being in the treatment group.

4. Matching of FIRST and potential comparison group members. Matching was done iteratively for each FIRST respondent by finding the closest possible match among propensity scores of Beginning Postsecondary Student Survey respondents. This procedure was accomplished using an SPSS macro developed by Raynald Levesque and adapted for use with propensity score matching by John Painter of the University of North Carolina.[2] After inspecting characteristics of matched cases for those where the propensity scores were not exactly the same, it was determined that even slight differences in scores could result in matched cases that were different on several of the characteristics used for matching, resulting in two populations that were not sufficiently well matched to compare outcomes

[1] For a technical discussion of propensity score matching, see Paul R. Rosenbaum and Donald B. Rubin, "Constructing a Control Group Using Multvariate Matched Sampling Methods that Incorporate the Propensity Score," *The American Statistician*, v. 39, no. 1 (February, 1985), 33-38.
[2] http://www.unc.edu/~painter/SPSSsyntax/propen.txt

with any degree of confidence. Consequently, we decided to aim for two populations that were exactly matched on all characteristics.

5. However, even with a large pool of 12,000+ potential comparison group members in the Beginning Postsecondary Student Survey, it was difficult to find exact matches for some FIRST respondents without changing some of the characteristics used in the matching procedure. Thus, instead of using a string of dummy variables for each race category (white, black, Hispanic, Asian, multiracial) and trying to match all of them, we instead used a 2-part categorization of race – white and non-white. Similarly, instead of trying to match on a series of high school math and science courses, we matched on whether each person had taken at least one math course from this list and at least one science course from the list. The result of this process was that we found 147 exact matches on nine characteristics shown below. Thus, we were able to find matches for all but nine of the 156 FIRST respondents with good information on characteristics used for the propensity matching procedure.

Demographic Background Measures	High School Academic Background Measures
▪ Race (White/Non-White) ▪ Gender (Male/Female) ▪ English as a second language ▪ Parent's education (whether at least one parent attended college) ▪ Economic status of the high school (percent of students eligible for free/reduced cost lunches)	Whether students had taken following courses: ▪ honors math class ▪ one honors science class ▪ at least one math class (from a list that included Algebra 1 and 2, Trigonometry, Geometry, Calculus, etc.) ▪ at least one science class (from a list that included Biology, Chemistry, Physics, etc.)

5. Using these matched samples, we compared the two populations on selected education, career, and developmental outcomes. One issue that arose in the analysis is that there were missing values in one or both populations on some outcome variables. In these cases, the numbers of valid responses in the two populations were different, meaning that without some adjustments the populations were no longer fully comparable. To adjust for this, whenever there were missing values on an outcome indicator, the cases with missing values along with their matched cases were removed from the analysis dataset. This had to be done separately for each outcome variable as the missing values were distributed differently for each outcome. Thus the size of the matched dataset varies by income measure (see Tables 4-8 and 4-9 in the main body of the report).

6. Differences in outcomes for the two populations were assessed for statistical significance using the Fisher's Exact Test. This test is considered more appropriate for 2 x 2 matrices (in our case, the test and comparison groups on one dimension and whether or not an individual achieved the outcome on the other dimension) than the Chi-Square Test and gives slightly more conservative results. In other words, using the Fisher's Exact Test, differences in the two populations have to be somewhat larger in order to achieve statistical significance than is the case with the Chi-Square Test.

First Robotics Competition
Alumni Survey

Thank you for taking the time to complete this survey. The information you provide will help FIRST tremendously as it works to expand and improve the FRC (FIRST Robotics Competition) program to include more schools and young people.

Please follow the survey directions carefully. You will only need to complete some sections of the survey, depending on what you have been doing since you left high school. The instructions in the survey will tell you which sections to complete.

We want to emphasize that your responses to the survey are confidential. The only people who will see your completed survey are the researchers at Brandeis University who are conducting this study. No one at FIRST or your school will see your individual answers. We hope that you will complete the survey as completely and honestly as you can.

THANK YOU!

Identifying Information (Please Print Clearly)

First Name _____ Last Name _____

Street Address _____ Apt. No. _____

City _____ State _____ Zip _____

Telephone ( ) _____ Email _____

Would you like us to send your "Thank You" gift of $20 to the address above? ❍ Yes ❍ No

If **NO**, where should we send it?

First Name _____ Last Name _____

Street Address _____ Apt. No. _____

City _____ State _____ Zip _____

What was the name of the most recent high school you attended? _____

Did you graduate from high school? ❍ Yes ❍ No
If YES, what year did you graduate? _____

A. Current Status

1. Which of the following best describes your current situation? Are you:

   - ❍ Graduated or left high school, but not in college (employed, in military, homemaker, unemployed, etc.) (**SKIP TO SECTION B**)
   - ❍ Attending college (**SKIP TO SECTION C**)
   - ❍ Still in high school. If you are still in high school, when do you expect to graduate? Month _____ Year _____ (**SKIP TO SECTION G**)

B. Not in College

1. If you are **not in college or high school**, are you doing any of the following (please check the one that best describes your current status):
   - ❍ Employed full or part-time
   - ❍ In the military
   - ❍ In vocational or technical school
   - ❍ A homemaker
   - ❍ Unemployed
   - ❍ Other (Please explain) _____

PLEASE COMPLETE THE QUESTIONS IN THIS SECTION THAT BEST RELATE TO YOUR CURRENT STATUS:

2. For those who are employed:

a. If you are employed, what is your current occupation/job title for your primary job?
_____

b. Does your current job involve working with science, math, engineering or technology?
❍ Yes ❍ No

c. How long have you been employed in this job? _____ Years

d. What were your approximate annual/total earnings in the past year (from all jobs)? $ _____

3. For those in the military

a. If you are in the military, what is your current rank/position? _____

b. What kind of job do you do (for example, radar operator, mechanic, etc.)?
_____

c. Does your current job involve working with science, math, engineering or technology?
❍ Yes ❍ No

d. How long have you been in the military? _____ Years

4. ***For those in vocational or technical school (not including 2 year colleges)***
   a. What is the primary field or occupation that you are studying? _____

   b. Does the occupation/field you are studying involve working with science, math, engineering or technology?
      ❍ Yes ❍ No

   c. When do you expect to complete your vocational or technical program? Month ___ Year _____

5. ***For those who are homemakers or* unemployed*?***
   a. If you are a homemaker or unemployed, have you held a full or part-time job since graduating high school? ❍ Yes ❍ No

   b. If Yes, what was your most recent job (occupation or job title)? _____

   c. Did your most recent job involve working with science, math, engineering or technology?
      ❍ Yes ❍ No

   d. How long were you in that job? _____ Years

FOR ALL RESPONDENTS*:*

6. Did you attend college (full or part-time) at any point since leaving high school?
   ❍ Yes (**Go to Section D**)
   ❍ No (**Skip to Section F**)

C. For Those Who Are Currently Attending College

If you are currently attending college, please answer the questions in this section of the survey.

1. What college do you attend: _____

2. What year did you begin attending this school? _____

3. What type of institution is the school?
   ❍ 2-year college ❍ 4-year college or university

4. What type of degree do you expect to earn at the school (check all that apply)?
   ❍ Associates Degree (AA) ❍ Master's Degree (MA)
   ❍ Bachelor's Degree (BA) ❍ Other Graduate Degree (Ph.D., MD., MBA, etc.)

5. When do you expect to graduate with your degree? Month _____ Year _____

6. In general, have you been attending college on a full-time basis, part-time, or a mix of full and part-time? (Please check one)
   ❍ Full-time most semesters
   ❍ Part-time most semesters
   ❍ Mix of full and part-time

7. At your current school, have you selected a major or primary program of study?
   ❍ Yes ❍ No

   a. If **YES**, what is your major or primary program of study? _____

   b. Do you have a second (or double) major? If so, what is that major? _____

   c. If **NO**, what is your most likely choice (or Don't Know) _____

8. Did you attend any colleges before the one you are currently attending?
   ❍ Yes ❍ No

   a. If **YES**, please list the school or schools you attended prior to your current college in the order that you attended them. For each college, please indicate if it was a 2-year or 4-year institution and the degree you received, if any.

School Name	TYPE OF INSTITUTION	Degree Received
	❍ 2 year college ❍ 4 yr college or university	❍ Associates (AA) ❍ Bachelor's (BA) ❍ Master's (MA) ❍ None
	❍ 2 year college ❍ 4 yr college or university	❍ Associates (AA) ❍ Bachelor's (BA) ❍ Master's (MA) ❍ None

9. What kind of job, if any, do you expect to have after completing your education?
   _____ (Job Title)

Please continue the survey at Section E

D. For Those Who Attended College Previously

Please complete this section if you are not currently in college, but attended college full or part-time before now.

1. If you are not currently in college, but attended college previously, please list the colleges you attended in the order that you attended them (for example, first college after high school in the first row, etc.). For each, please indicate if it was a 2 year or 4 year institution and the degree you received, if any.

School Name	TYPE OF INSTITUTION	Degree Received
	❍ 2 year college ❍ 4 yr college or university	❍ Associates (AA) ❍ Bachelor's (BA) ❍ Master's (MA) ❍ None
	❍ 2 year college ❍ 4 yr college or university	❍ Associates (AA) ❍ Bachelor's (BA) ❍ Master's (MA) ❍ None
	❍ 2 year college ❍ 4 yr college or university	❍ Associates (AA) ❍ Bachelor's (BA) ❍ Master's (MA) ❍ None

2. At the college you attended **most recently**, did you generally attend on a full-time basis, part-time, or a mix of full and part-time? (Please check one)
   - ❍ Full-time most semesters
   - ❍ Part-time most semesters
   - ❍ Mix of full and part-time

3. At your most recent school, did you select a major or primary program of study?
   - ❍ Yes ❍ No

   a. If YES, what was your major or program of study? _____

   b. Did you have a second (or double) major? _____

4. If you left college **without** a degree, what was your primary reason for stopping/dropping out?
   - ❍ Academic problems
   - ❍ Not satisfied with school (didn't like classes, wanted to take time off, etc.)
   - ❍ Financial issues
   - ❍ Family issues
   - ❍ Other (please explain) _____

Please continue the survey at Section E

E. College Courses, Employment and Internships

Please answer the questions in this section if you are currently attending college or attended at any point since high school.

1. During **any** of your years in college, did you take courses in any of the following subject areas. Please indicate which subjects you took and in which years.

Subject	1st Year (Freshman)	2nd Year (Sophomore)	3d Year (Junior)	4th Year (Senior)
Math	❍	❍	❍	❍
Science/Technology	❍	❍	❍	❍
Computer Science	❍	❍	❍	❍
Engineering	❍	❍	❍	❍

2. During any of your years in college, **did you have an internship, apprenticeship, co-op (cooperative) job, part-time job, or summer job** in a field related to math, science/technology, computer science, or engineering? If so, please indicate which type of internships or jobs you had each year. (Please include the summer *prior* to each school year. For example, Freshman year includes the summer before your first semester as a Freshman in college.)

Type of Internship, Job, etc.	1st Year (Freshman)	2nd Year (Sophomore)	3d Year (Junior)	4th Year (Senior)
Internship	❍	❍	❍	❍
Apprenticeship	❍	❍	❍	❍
Co-op Job	❍	❍	❍	❍
Part-time Job	❍	❍	❍	❍
Summer Job	❍	❍	❍	❍

3. During any of your years in college, **did you have an internship, apprenticeship, co-op (cooperative) job, part-time job, or summer job** in a field **NOT** related to math, science, computer science or engineering? (That is, an internship or job not included in the question above.) If so, please indicate which type of internships or jobs you had each year. (Please include the summer *prior* to each school year. For example, Freshman year includes the summer before your first semester as a Freshman in college.)

Type of Internship, Job, etc.	1st Year (Freshman)	2nd Year (Sophomore)	3d Year (Junior)	4th Year (Senior)
Internship	❍	❍	❍	❍
Apprenticeship	❍	❍	❍	❍
Co-op Job	❍	❍	❍	❍
Part-time Job	❍	❍	❍	❍
Summer Job	❍	❍	❍	❍

4. During **any** of your years in college, **did you receive any grants or scholarships** (excluding loans) related to math, science, computer science or engineering, or any other grants or scholarships?

Grants/Scholarships	1st Year (Freshman)	2nd Year (Sophomore)	3d Year (Junior)	4th Year (Senior)
Math Grants or Scholarships	❍	❍	❍	❍
Science/Technology Grants or Scholarships	❍	❍	❍	❍
Computer Science Grants or Scholarships	❍	❍	❍	❍
Engineering Grants or Scholarships	❍	❍	❍	❍
Other Grants or Scholarships	❍	❍	❍	❍

5. For each of your years in college, can you tell us what kinds of grades you received in your courses: for example, mostly As, As and Bs, mostly B, etc.

Grades	1st Year (Freshman)	2nd Year (Sophomore)	3d Year (Junior)	4th Year (Senior)
Mostly As (3.75 and above)	❍	❍	❍	❍
A's and B's (3.25-3.74)	❍	❍	❍	❍
Mostly B's (2.75-3.24)	❍	❍	❍	❍
B's and C's (2.25-2.74)	❍	❍	❍	❍
Mostly C's (1.75-2.24)	❍	❍	❍	❍
C's and D's (1.25-1.74)	❍	❍	❍	❍
Mostly D's or below (Below 1.75)	❍	❍	❍	❍
Don't Know/Don't Remember	❍	❍	❍	❍

Please continue the survey at Section F

F. Other Education

1. Have you attended any educational programs after high school other than a 2 or 4-year college (for example, vocational or technical training school or job training courses)?
   ❍ Yes ❍ No

2. If yes, did you complete the program and/or receive a certificate?
   ❍ Yes ❍ No

3. What was the primary field or occupation that you studied in the most recent school or training program you attended? _____

4. If you attended more than one occupational training program, were any of the programs in fields related to math, science, computer science, or engineering?
   ❍ Yes ❍ No

G. Life Outside of School and Work

1. In the past year, have you participated in any community service or volunteer work, other than court-ordered service?
   ❍ Yes ❍ No

2. If YES, what was the community service or volunteer work that you did this past year? (Please check all that apply)
   ❍ Tutoring, or other education related work with kids
   ❍ Other work with kids (coaching, Scouts, big brother/big sister, etc.)
   ❍ Fundraising (not political)
   ❍ Fundraising (political)
   ❍ Homeless shelter/soup kitchen
   ❍ Telephone crisis center/rape crisis/intervention/counseling
   ❍ Neighborhood improvement/clean-up/Habitat for Humanity
   ❍ Health Services/Hospital, nursing home, group home
   ❍ Adult literacy project
   ❍ Volunteer fire/EMT
   ❍ Assisted a high school FIRST Robotics team
   ❍ Assisted a middle school FIRST LEGO® League team
   ❍ Other _____

3. On average, how many hours per month did you volunteer?
   _____ hours per month on average **OR** ❍ One time event only

4. Please tell us if each of the following personal goals is **very important**, **somewhat important**, or **not important** to you:

	Very Important	Somewhat Important	Not Important
a. Being a leader in the community	❍	❍	❍
b. Being well-off financially	❍	❍	❍
c. Becoming an authority in your field	❍	❍	❍
d. Influencing the political structure/being politically active	❍	❍	❍
e. Being successful in your career	❍	❍	❍
f. Running your own business	❍	❍	❍

5. What is the highest level of education you ever expect to achieve? (If you do not expect to achieve a higher level, enter your current level):

   ❍ No degree or certificate
   ❍ Certificate
   ❍ Associate's degree
   ❍ Bachelor's degree
   ❍ Post-baccalaureate certificate
   ❍ Master's Degree (MA/MS)
   ❍ Other Graduate Degree (Ph.D., MBA, MD, etc.)

H. Experience with FIRST Robotics

The questions in the following section ask about your experience on the FIRST Robotics Competition team at your high school or in your community. Please think back to your time in the program and answer as accurately and completely as you can.

1. During which years in high school were you on a FIRST Robotics team at your high school or in your community?

   ❍ 9th grade
   ❍ 10th grade
   ❍ 11th grade
   ❍ 12th grade

2. For each year that you were involved in FIRST in high school, please check those activities that you were directly involved in as part of your FIRST Robotics team. Please check ***only*** those activities that you were directly involved in (that is, do not check them if they were done by others on the team without your direct involvement). Please check all that apply.

	9th Grade	10th Grade	11th Grade	12th Grade	Don't Know
a. Deciding on the team's overall strategy for the competition	❍	❍	❍	❍	❍
b. Designing the team's robot or a specific part of the robot	❍	❍	❍	❍	❍
c. Building the robot or a specific part of the robot	❍	❍	❍	❍	❍
d. Programming the robot	❍	❍	❍	❍	❍
e. Designing or building a team website	❍	❍	❍	❍	❍
f. Developing the team CAD/CAM presentation	❍	❍	❍	❍	❍
g. Participating in a community service project with your team	❍	❍	❍	❍	❍
h. Raising money or doing publicity for the team	❍	❍	❍	❍	❍
i. Attending a FIRST regional competition	❍	❍	❍	❍	❍
j. Working on or operating the robot at a FIRST regional competition	❍	❍	❍	❍	❍
k. Making a presentation to the judges at a FIRST regional competition	❍	❍	❍	❍	❍
l. Attending a FIRST national competition	❍	❍	❍	❍	❍

3. Looking back across your experience in FIRST as a whole, how would you rate your level of involvement in the program? Please circle the number that reflects your level of involvement, using a scale from 1 (Not Involved) to 5 (Very Involved).

Not Involved				Very Involved
1	2	3	4	5

4. How well do the following statements describe your experience on the FIRST Robotics team in high school? For each statement, please tell us whether you **strongly agree**, **agree**, **disagree** or **strongly disagree**. If you were on a team for several years, please answer in terms of your typical or most common experiences on the team.

Statement	Strongly Agree	Agree	Disagree	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 real responsibilities on my team.	❍	❍	❍	❍
d. I had a chance to play a leadership role on my team.	❍	❍	❍	❍
e. The adults on my team did most of the difficult jobs in building the robot.	❍	❍	❍	❍
f. I had a chance to get to know at least one of the adults on my team very well.	❍	❍	❍	❍
g. I felt like I learned a lot from the adults on my team.	❍	❍	❍	❍
h. I learned new skills while working on the team.	❍	❍	❍	❍
i. I had fun working on the FRC team.	❍	❍	❍	❍
j. I felt like I really belonged on my team.	❍	❍	❍	❍
k. I almost always felt that my team had a good chance to win something at the regional competition.	❍	❍	❍	❍

5. We are also interested in the impact of FIRST on you as an individual. For each of the following statements about FIRST's impact, please tell us whether you **strongly agree**, **agree**, **disagree** or **strongly disagree**.

	Strongly Agree	Agree	Disagree	Strongly Disagree
a. I gained a sense of self-confidence by being in FIRST	❍	❍	❍	❍
b. My interest in science and technology greatly increased as a result of being in FIRST	❍	❍	❍	❍
c. I gained a better idea of what I wanted to study in college or vocational school as a result of FIRST	❍	❍	❍	❍
d. I became more interested in a career that involved math, science or technology as a result of FIRST	❍	❍	❍	❍
e. FIRST helped motivate me to do better in school	❍	❍	❍	❍
f. I gained a better understanding of how math, science and technology are used to solve problems in the real world	❍	❍	❍	❍
g. I became more active in my community as a result of FIRST	❍	❍	❍	❍
h. FIRST made me want to help younger students learn more about math and science	❍	❍	❍	❍
i. FIRST helped me understand the role of 'gracious professionalism' in everyday life	❍	❍	❍	❍
j. FIRST helped me understand the value of working on a team	❍	❍	❍	❍

6. Looking back at your experience in FIRST, to what extent do you think that FIRST helped you learn or strengthen the following skills? For each skill, please tell us whether FIRST helped you: **A Lot, Some**, **Very Little**, or **Not at All**.

Skills	A Lot	Some	Very Little	Not at All
a. Listen and respond to other people's suggestions or concerns	❍	❍	❍	❍
b. Talk with people to get the information you need	❍	❍	❍	❍
c. Stop or decrease conflicts between people	❍	❍	❍	❍
d. Get along with other students, co-workers, teachers, and supervisors	❍	❍	❍	❍
e. Learn new ways of thinking or acting from other people	❍	❍	❍	❍
f. Solve unexpected problems or find new or better ways to do things	❍	❍	❍	❍
g. Weigh different issues and possibilities before making a decision	❍	❍	❍	❍
h. Know how to gather and analyze information from different sources	❍	❍	❍	❍
i. Work within the rules of a new organization or team	❍	❍	❍	❍
j. Manage your time when you are under pressure	❍	❍	❍	❍
k. Use practical math skills, such as graphs, tables, or estimating costs	❍	❍	❍	❍
l. Use computers to get or analyze information	❍	❍	❍	❍
m. Make a presentation in front of people that you do not know	❍	❍	❍	❍

7. What aspect of FIRST do you think had the greatest impact on you? What was the most important part of the FIRST experience for you?

8. Can you give an example of how your FIRST experience has made a lasting impact on you (if it has) in the years since high school?

9. What did you enjoy least about your time in FIRST? What would you change?

10. Overall, how would you rate your experience in FIRST?

- ❍ Excellent
- ❍ Good
- ❍ Fair
- ❍ Poor

11. Looking back, how important an influence was FIRST on your life after high school, compared to other school or community-based activities that you were involved in? Was FIRST:

- ❍ Much more influential
- ❍ A little more influential
- ❍ About the same as other activities
- ❍ A little less influential
- ❍ Much less influential

I. High School Classes and Grades

1. **How many years of courses did you take in high school (grades 9-12) in each of the subjects listed below**. If you did not take any courses in a subject, please mark 'None." If one or more of the courses in a subject was an advanced placement, accelerated or honors course, please also mark the circle in the 'Honors' column.

	Years of Study							
Subject	**None**	**Less than 1 Year**	**1**	**2**	**3**	**4**	**More than 4**	**Honors**
Arts and Music (for example, art, music, art history, dance or theatre)	❍	❍	❍	❍	❍	❍	❍	❍
English (for example, composition, grammar, or literature)	❍	❍	❍	❍	❍	❍	❍	❍
Foreign and Classical Languages	❍	❍	❍	❍	❍	❍	❍	❍
Mathematics	❍	❍	❍	❍	❍	❍	❍	❍
Natural Sciences (for example, biology, chemistry or physics)	❍	❍	❍	❍	❍	❍	❍	❍
Social Sciences and History (for example, history, government or geography)	❍	❍	❍	❍	❍	❍	❍	❍

2. Which, if any, of the specific courses listed below did you take in high school (grades 9-12)? If one or more of the courses was an honors course, please also mark the circle in the 'Honors' column.

Subject	Took at least 1 Semester	Honors
Algebra 1	❍	❍
Geometry	❍	❍
Algebra 2	❍	❍
Trigonometry	❍	❍
Pre-Calculus	❍	❍
Calculus	❍	❍
Biology	❍	❍
Chemistry	❍	❍
Physics	❍	❍

3. As best as you remember, what was your *average* grade in math and science for all of your courses in those subjects in high school (grades 9-12)?

	Math	Science
A or excellent (usually 90-100)	❍	❍
B or good (usually 80-89)	❍	❍
C or fair (usually 70-79)	❍	❍
D or passing (usually 60-69)	❍	❍
E or F or failing (usually 59 or below	❍	❍
Don't Know/Don't Remember	❍	❍

4. What was your cumulative grade point average (GPA) for all academic subjects in high school. If you do not know, please give your best estimate.

❍ A+ (97-100)
❍ A (93-96)
❍ A- (90-92)
❍ B+ (87-89)
❍ B (83-86)
❍ B- (80-82)
❍ C+ (77-79)
❍ C (73-76)
❍ C- (70-72)
❍ D+ (67-69)
❍ D (65-66)
❍ E or F (below 65)
❍ Don't Know/Don't Remember

5. Did you take the SAT (Scholastic Aptitude Test) in high school? ❍ Yes ❍ No

If YES, what were your scores? _____ Math _____ Verbal _____ Total ❍ Don't Know

6. Did you take the ACT exam in high school? ❍ Yes ❍ No

If YES, what were your scores _____ Math _____ Verbal _____Total ❍ Don't Know

J. Personal Background

Please tell us about your own background and demographic characteristics

1. How old are you? _____ Years

2. Are you male or female? ❍ Male ❍ Female

3. How would you describe your racial or ethnic background (Check all that apply)?
   - ❍ African-American
   - ❍ Asian/Pacific Islander
   - ❍ Hispanic/Latino
   - ❍ Native American/Alaskan
   - ❍ White
   - ❍ Other/Multi-racial _____

4. When you were growing up, was English the primary language spoken at home?
   - ❍ Yes ❍ No

5. What is your current marital status?
   - ❍ Married
   - ❍ Single
   - ❍ Divorced
   - ❍ Widowed

6. What was the highest grade or level of education completed by your father (or male guardian) and your mother (or female guardian)? Please check only one answer for each parent.

Highest level of education	Father/Male Guardian	Mother/ Female Guardian
Less than high school	❍	❍
Graduated high school	❍	❍
Business or trade school	❍	❍
Some college	❍	❍
Associate or two-year college degree	❍	❍
Bachelor's or four-year college degree	❍	❍
Master's degree or equivalent	❍	❍
Other graduate d (Ph.D., MD, MBA, etc.)	❍	❍
Don't Know	❍	❍

K. Other Comments

Any other comments about your experience in FIRST and/or its impact on your life?

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS SURVEY.

Please be sure to seal the survey in the postage-paid return envelope that has been provided to you and return it to:

The Center for Youth and Communities
Brandeis University
60 Turner Street, 2nd Floor
Waltham, MA 02453

If you have any questions about the survey, please feel free to contact us:
by email at cycsurvey@courier.brandeis.edu
by phone (toll-free) at: 866-343-9002

TEAM PROFILES: FRC SITE VISITS

NEW YORK

Morris High School- Team 395

Located in the South Bronx, one of the nation's poorest communities, Morris High School is comprised of five 'small schools' within the school, with approximately 1000 students total. This season marks the team's sixth year. The team of about 15 students is mentored by a group of Columbia University students and meets at the university because Morris does not have a shop facility. Because the team must travel for club meetings, often late at night, some parents have been wary of letting their student join FRC, which has kept the team size small. The mentors assist the students with robotics, but also have structured sessions for homework help, SAT preparation, and college application and scholarship assistance. The team has been successful in gaining positive publicity for the team and the school. The team and mentors are also heavily involved with coaching and mentoring FIRST LEGO® League teams.

Ralph McKee High School- Team 522

McKee is a school of roughly 650 students (64 % male) located on Staten Island. Five years ago, the principal encouraged McKee to start an FRC team. McKee was paired with Curtis High School in its first year as a team, but since then have formed their own team. The McKee team is unique in that they do not have any corporate or university mentors; because McKee is a Career and Technical Education school, coaches have felt that any assistance could be provided by in-house machinists, CAD teachers, graphic arts teachers, etc. Another unique feature is that the coaches have created a course modeled after their experience with the FRC team. The course is structured around a series of projects and competitions designed to show students the practical application of physics (e.g. Newton's 2nd and 3rd Laws). So far, this is only a one-year class, but the teachers are hoping that they will be able to institutionalize a four-year course that would integrate several school disciplines. At the time of the site visit, the team was finding it very difficult to obtain sponsorship for the coming year.

Brooklyn Technical High School- Team 334

Brooklyn Tech is located in Brooklyn, but draws students from all across the city as it is an exam school. There are a little over 4,000 students who attend. The team was formed in 1999 as a strategy for bringing back an engineering discipline to the school. The school has a large shop facility, and the team allows other area teams to use this space.
They receive mentoring from Securities Industry Automation Corporation (SIAC) and a Brooklyn Polytechnic University student.

George Westinghouse High School- Team 354

This is the George Westinghouse team's sixth year. George Westinghouse is located in Brooklyn and has approximately 1,200 students, almost 70% of which are males. As such,

recruiting girls for the team has been somewhat of a challenge. The team has been successful in getting other student groups to support them by making the team signs and attending tournaments to cheer. They currently receive mentoring from Securities Industry Automation Corporation (SIAC) and FRC alumni.

Washington Irving High School- Team 331

The Washington Irving team started around 1998. Washington Irving is a school of over 2,800 students located in Manhattan. The team represents a cross-section of students from various genders, races, academic programs, and social groups. They receive mentoring from Con Edison, the regional utility company. Washington Irving is the first team that Con Edison mentored; the company has been with the team since its inception and is now mentoring other teams as well.

Michigan

Hamtramck- Team 123

Team #123, from Hamtramck High School, has been competing in FIRST since 1997. This school of approximately 1,000 students is located in a Detroit area neighborhood that is largely made up of new immigrants. Their major sponsor is Ford, while technical support is provided by a small machine shop that works with several other Detroit area teams. School involvement includes three teachers and several additional assistants. From the beginning, school administration saw the team as a "bright star" and has been supportive of the program. Despite teacher lay-offs and fiscal constraints within the school system, the coaching staff receive stipends. Since their participation in FIRST, the school has begun offering AutoCAD and made improvements in their CAD courses. They have found that even mentors that are no longer officially partnering with the team (due to layoffs or company closings, or loss of corporate sponsorship) often continue to work with the team.

Buena Vista- Team 49

Team #49 is from Buena Vista High School, which is located about 1.5 hours north of Detroit, in Saginaw MI. With a total school population of less than 350 students, most of whom are low income and minority, this is one of the smallest public schools that participates in FIRST. About one-third of their students apply to be on the team. Their first sponsor was Delphi. Dow Chemical has been a major sponsor in recent years. In addition to technical instruction, mentors have provided training in team building and media relations. The larger student body at Buena Vistas has been supportive of the team. For example, even students who are not team members will offer to help with fundraising and other tasks. Parents are also enthusiastic fundraisers. The coaching staff includes a lead teacher and three other teachers as well.

Cooley- Team 557

Team #557, which partners with Ford, is from a Detroit school of more than 1,700 students. Mentors include both employed and retired engineers. It is a small team of about 10 students, which has sustained itself over the years despite challenges in working with the Detroit Public

School System as well as difficulty in recruiting teachers to the coaching staff. They have had travel restrictions placed upon them due to security concerns, as well as local transportation challenges. They have been able to use some of the robotics equipment for a physics course taught by the team leader.

Osborn- Team 515

Osborn High is a large school of about 2,000 students located in Detroit. Team #515 has partnered with GM since 2001. The team has always had strong female participation. They make use of the GM Tech Center, a large research facility, for robot building several times per week. Students enjoy working with teams from other schools at the facility. All 9th graders at Osborn are exposed to Robotics through a required course, which was added to the curriculum in part due to FRC. However, they would like to work toward even more incorporation of robotics concepts into their curriculum. Parents and relatives of team members have been particularly helpful with driving team members. The team is headed by a lead teacher, with an additional four teachers on the coaching staff.

Pontiac Central- Team 47

Team #47 started in 1996 after being approached by the Delphi Corporation, which had already had employees mentoring students in Pontiac Central. The school of about 1,200 students is located in Pontiac, MI, which is about 30 miles north of Detroit. The team structures the season into a "Club" phase, which lasts from September through December, followed by the build phase. Students in the club typically move onto the build phase. They have a coaching staff of five teachers and also enjoy coaching assistance from alumni team members and mentoring from Delphi. The team dresses in their full team uniforms to demonstrate the robot at events like Parent-Teacher Conference Day. The coaching staff emphasizes etiquette, personal courtesy and public speaking skills. They also try to create opportunities for social interaction with students from other teams at events. They have been leaders in providing assistance to other FRC teams.