

**4-H Robotics:
A Study of Youth Enrolled in Lockheed Martin-
Supported Programs**

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Overview

National 4-H developed a comprehensive robotics program in 2009 to increase youth interest and awareness of robotics, engineering, and technology. In 2012, with support from Lockheed Martin, National 4-H began efforts to expand the program by adding new clubs, increasing professional and volunteer development, and engaging Lockheed Martin employees as youth mentors.

For National 4-H Council, Policy Studies Associates (PSA) is conducting a two-year study of youth enrolled in robotics clubs supported by Lockheed Martin. The goals of the study are to obtain data on youth's engagement, attitudes, interests, and educational and career aspirations related to science and engineering; the survey also seeks to inform stakeholders, including the project's funder and state and local club leaders, about the project's progress in increasing youth interest in science and engineering and promoting educational and career aspirations in science- and engineering-related fields.

The study uses data collected through the 4-H Robotics Youth Survey; the survey is based on the Youth Engagement, Attitudes, and Knowledge (YEAK) survey developed by PSA with National 4-H for an evaluation of the 4-H Science Initiative. The survey also draws from assessments developed by the University of California-Davis, the Assessing Women and Men in Engineering Project, and the National Assessment of Educational Progress (NAEP). The 4-H Robotics Youth Survey seeks to address the following questions:

- What are the characteristics of youth participating in Lockheed Martin-funded 4-H Robotics programs?
- What are participants' attitudes toward science, technology, and engineering? Do participants aspire to pursue career opportunities in these fields?
- What level of education do participants want to achieve?
- What science- and engineering-related skills, abilities, and knowledge do participants have?
- What outcomes are associated with participation in robotics programming?

Participating Land Grant Universities

For the 2013 program year, seven land grant universities (LGUs) received funding to support robotics programs. However, one LGU conducted its own assessment of youth enrolled in robotics programs and, therefore, did not participate in PSA's data collection efforts. Another LGU did not receive approval from its Institutional Review Board in time to administer surveys. The five LGUs that participated in the 2013 survey administration include:

- The University of Arkansas
- The University of Maryland

- The University of Georgia
- The University of Kentucky
- Texas A&M University

Survey response rates. Staff at each LGU provided a list of robotics clubs operating with support from Lockheed Martin and the number of youth enrolled in each club. To reach clubs meeting both during the school year and during the summer, evaluators administered youth surveys from April until November 2013. Club leaders were instructed to survey all eligible youth present on the designated survey administration day(s). In order to ensure that the responding youth would be representative of the youth in their clubs, evaluators emphasized the importance of administering the surveys to all youth, regardless of their science abilities or engagement in the program.

Based on the information provided by state-level staff, evaluators calculated that a total of 233 youth were enrolled in the Lockheed Martin-funded 4-H Robotics clubs that returned surveys. Of these 233 youth, 197 returned surveys, for a response rate of 85 percent.

Exhibit 1 Youth-level response rates

LGU	Number of youth enrolled in clubs	Number of youth in clubs that returned surveys	Completed youth surveys	Youth-level response rate (in percent)
The University of Arkansas	160	20	15	75
The University of Maryland	95	24	20	83
The University of Georgia	91	20	13	65
The University of Kentucky	160	120	105	87
Texas A&M University	133	49	44	90
<i>Total</i>	639	233	197	85

4-H Robotics Participants

Demographics

A total of 197 youth responded to the survey. Among the youth who reported demographic characteristics, 60 percent were boys, and 77 percent were between the ages of 11 and 14 (Exhibit 2). Because previous studies of interest in STEM careers have found mothers' education levels to have a strong influence on youth outcomes (Haveman, Wolfe, & Spaulding, 1991), youth were asked to report the highest level of education completed by their mother. Fifty-four percent of respondents reported that their mother had completed a four-year college

degree or more, 23 percent reported that their mother had attended high school or grade school, and 23 percent of youth did not know.

Youth who responded to the survey most often identified themselves as White (75 percent). Youth could identify themselves as being of more than one race.

Exhibit 2
Youth demographic characteristics
(n=196)

	Percent of respondents	
Gender	Male	60%
	Female	40
Age	10 or younger	8
	11 – 14	77
	15 or older	15
Mother’s education	College or more	54
	Less than college	23
	Unsure	23
Race/ethnicity*	White	75
	African American	15
	Other	6
	Native American	5
	Hispanic	4
	Asian	1
	Native Hawaiian	0

Exhibit reads: Sixty percent of survey respondents were male, and 40 percent of respondents were female.

*Youth could select more than one response.

Exposure to 4-H

Prior experiences with 4-H might affect youth’s attitudes toward science, engineering, and technology, as well as their career aspirations. Knowledge of youth’s prior involvement in 4-H and their experiences in activities focused on science, engineering, and technology are important factors not only in describing the surveyed population but also in understanding youth’s attitudes and aspirations.

While more than half of the youth surveyed had prior experience in 4-H (55 percent), this was the first time that nearly three-quarters of the youth (73 percent) participated in a 4-H club or in an activity related to robotics. Youth joined their 4-H Robotics clubs for a variety of reasons, the most frequently reported being that they thought their robotics club would be fun (53 percent) and that they wanted to learn about robotics (41 percent). Youth could select more than one reason for joining their 4-H Robotics clubs.

Engagement in and Attitudes Toward Science, Engineering, and Technology

Overall, survey respondents reported being aware of and interested in activities related to science, engineering, and technology. As displayed in Exhibit 3, the majority of youth agreed strongly or agreed that they like to build and construct things (98 percent) and that they like to work on science projects (92 percent). The majority of youth also agreed strongly or agreed that science, engineering, and technology are useful for solving everyday problems (97 percent) and that they wanted to learn more about science, engineering, or technology (96 percent).

Exhibit 3
Youth interest and attitudes toward
science, engineering, and technology (n=197)

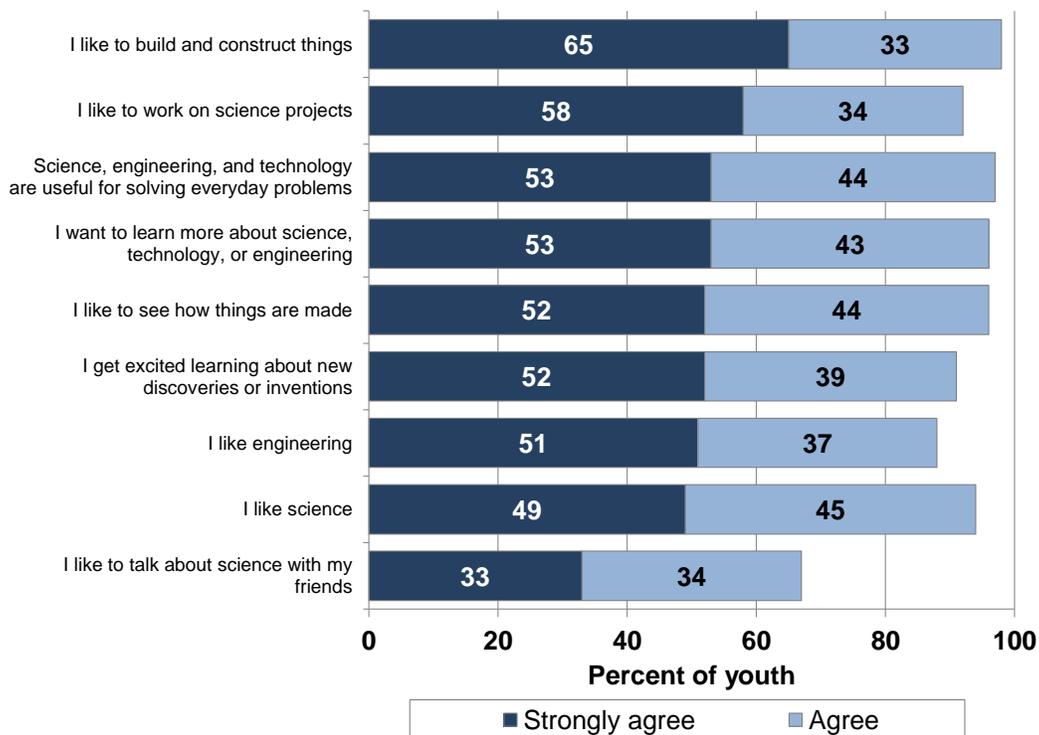


Exhibit reads: Sixty-five percent of youth agreed strongly that they like to build and construct things. Thirty-three percent of youth agreed with this statement.

The majority of surveyed youth also expressed interest in pursuing education related to science, engineering or technology. As displayed in Exhibit 4, 91 percent of youth reported that they are very or somewhat likely to learn about different science, engineering, or technology careers. Similarly, 89 percent of surveyed youth are very or somewhat likely to take advanced math and science classes at their school.

Exhibit 4
Youth interest in science- and engineering-related education (n=195)

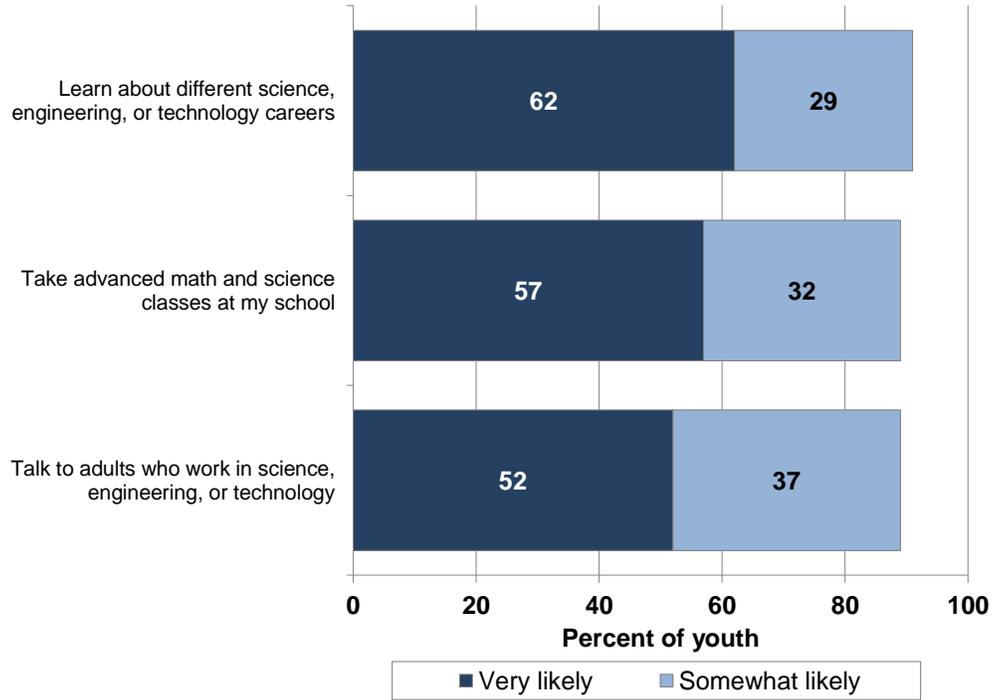


Exhibit reads: Sixty-two percent of youth reported that they are very likely to learn about different science, engineering, or technology careers. Twenty-nine percent of youth reported that they are somewhat likely to do so.

Science and Engineering Self-Efficacy

Research on self-efficacy suggests that youth’s beliefs in their capability to complete tasks may influence youth development outcomes. One study, for example, found that adolescents’ self-efficacy was a predictor of their college major and career choice (Brown & Lent, 2006). In general, surveyed 4-H Robotics participants reported high levels of self-efficacy related to science and engineering. Ninety-three percent of youth agreed strongly or agreed that they can do well in math and science classes. The majority of youth also agreed or agreed strongly that they can succeed in careers related to science and engineering (Exhibit 5).

Exhibit 5
Youth STEM-related self-efficacy (n=196)

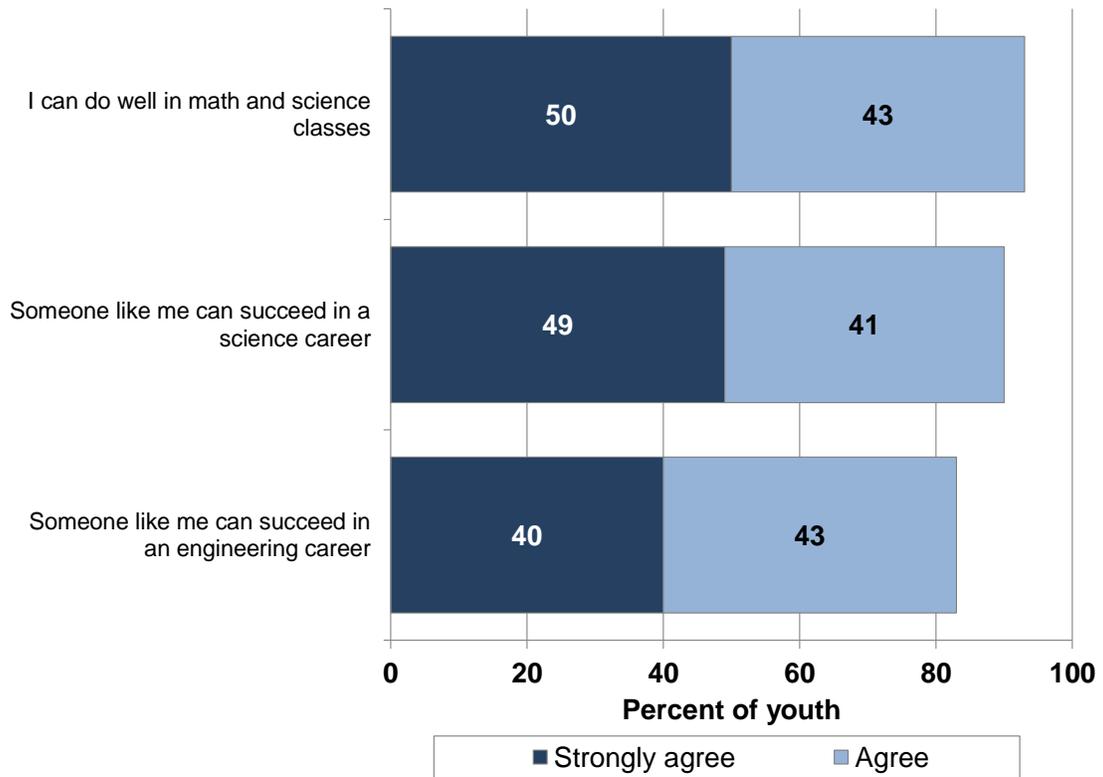


Exhibit reads: Fifty-percent of youth agreed strongly that they can do well in math and science classes. Forty-three percent of youth agreed with this statement.

As with their assessments of their science and engineering capabilities, the majority of youth also gave positive reports of their related skills (Exhibit 6). Youth were confident in their ability to design and build things to solve problems (90 percent), test engineering designs (84 percent), and make a chart or picture to show information (81 percent).

Exhibit 6
Science and engineering skills (n=195)

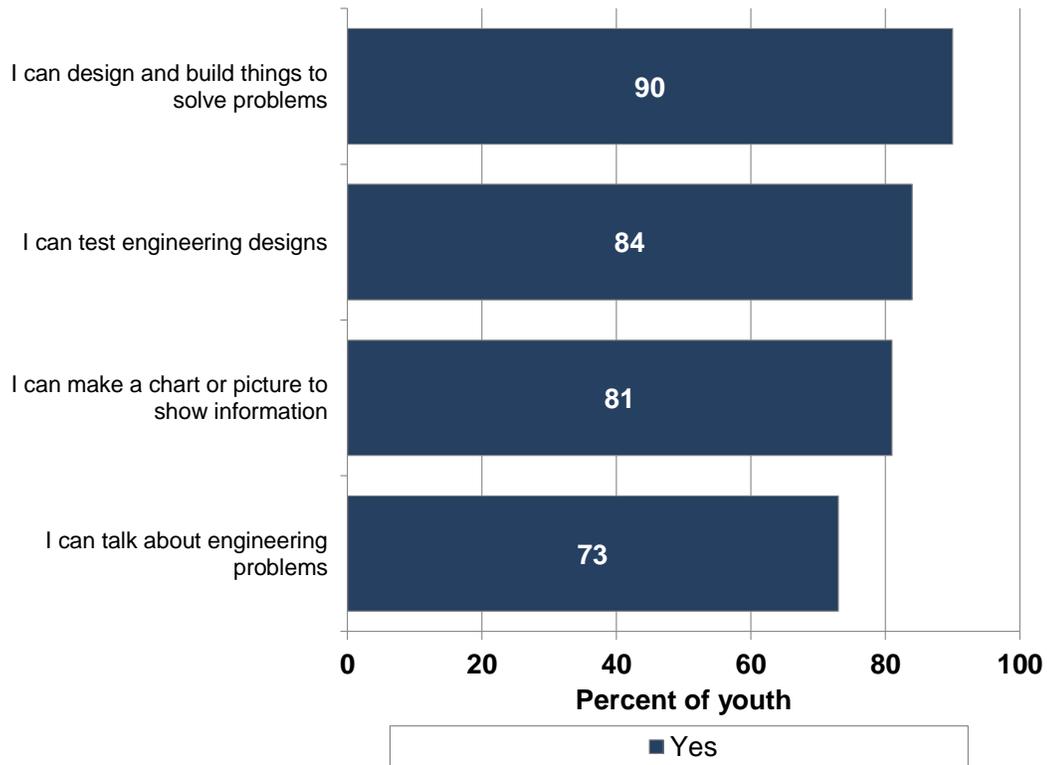


Exhibit reads: Ninety-percent of youth reported that they can design and build things to solve problems.

Robotics Program Activities and Benefits

To provide insight into what attracts youth to 4-H Robotics, youth were asked to report on the characteristics of their clubs. As shown in Exhibit 7, the overwhelming majority of youth agreed strongly or agreed that they do hands-on activities (99 percent), that adults listen to what they have to say (96 percent), and that they see science or engineering in a fun way in their club (96 percent).

Exhibit 7
Characteristics of 4-H Robotics clubs (n=197)

In this 4-H club ...

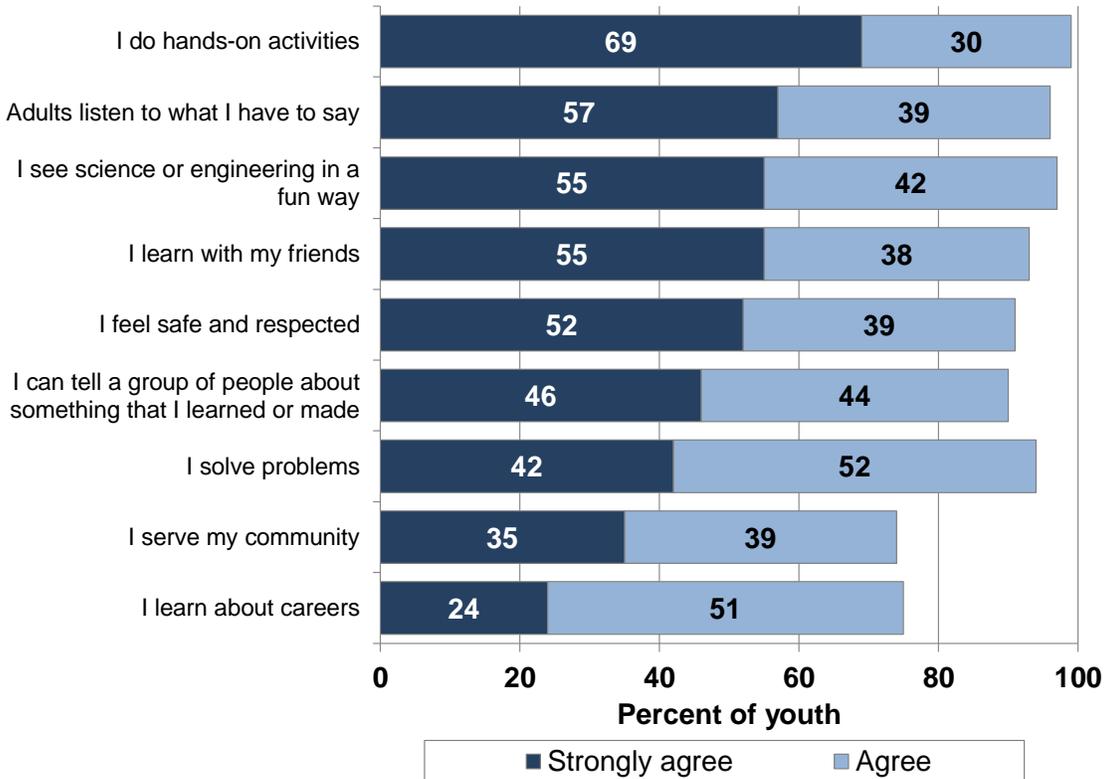


Exhibit reads: Sixty-nine percent of youth agreed strongly that they do hands-on activities in their 4-H club. Thirty percent of youth agreed with this statement.

The survey also asked youth to report on the perceived benefits of 4-H Robotics clubs. Ninety-seven percent of youth agreed strongly or agreed that participating in 4-H Robotics helped them gain a better understanding of science and engineering. Ninety percent agreed strongly or agreed that participating in these activities made them want to participate in other activities with a similar focus and made them more interested in studying science, engineering, or technology in school (Exhibit 8).

Exhibit 8
Benefits of 4-H Robotics clubs (n=192)

Participating in 4-H Robotics has...

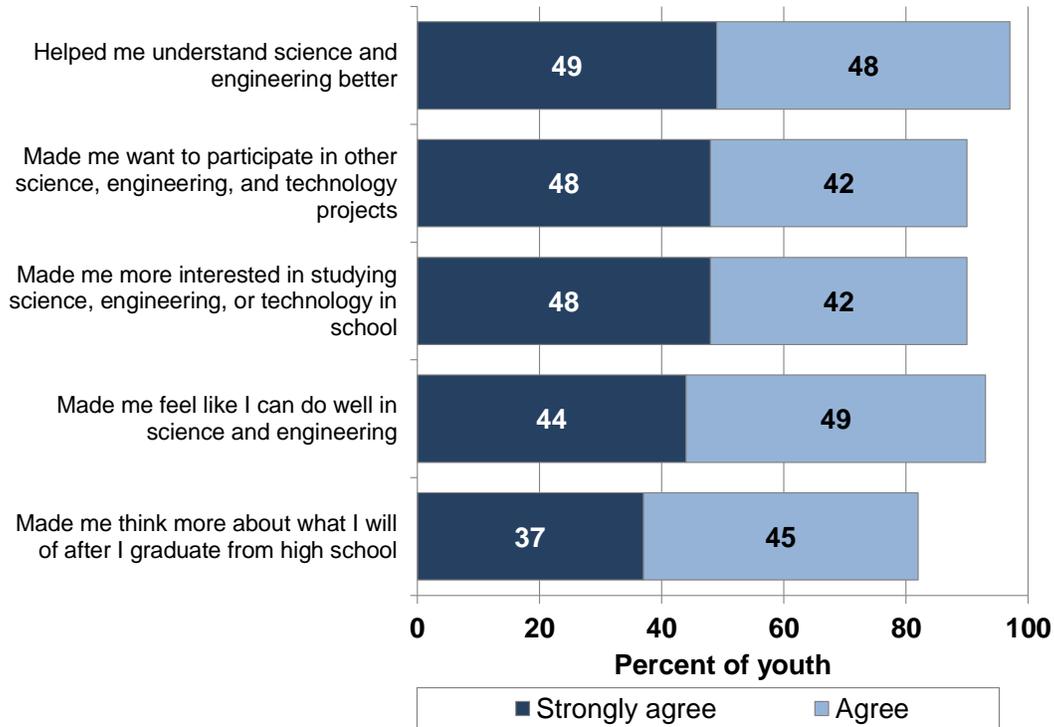


Exhibit reads: Forty-nine percent of youth agreed strongly that participating in 4-H Robotics has helped them understand science and engineering better. Forty-eight percent of youth agreed with this statement.

Educational and Career Aspirations

Overall, surveyed youth had high educational aspirations. When asked how far they wanted to go in school, 50 percent reported that they want to finish college, and 39 percent of youth said they aspire to get more education after college. Fifty-two percent of surveyed youth in 4-H Robotics clubs said “yes” when asked if they wanted to get a job related to science, engineering, or technology. For context, similar percentages of youth participating in 4-H Science programs expressed interest in pursuing a STEM career. A 2013 study of youth in 4-H Science programs, for example, found that 59 percent wanted a STEM-related career (Mielke & Butler, 2013).

Research on the career interests and aspirations of young people suggests that interest in science careers may form at an early age. An analysis of longitudinal data from youth participating in the 1988 National Educational Longitudinal Study highlights the importance of students’ interest in science careers as early as eighth grade in their eventual pursuit of a science major (Tai, Liu, Maltese, & Fan, 2006). Tai et al.’s (2006) analysis of NELS data focused on the independent variable derived from the survey question “What kind of work do you expect to be doing when you are 30 years old?” to examine the relationship between career expectations of

pre-adolescent youth and their baccalaureate concentration. The analysis found that young adolescents with expectations of having a career in science were more likely to graduate from college with a science degree, which highlights the importance of early encouragement.

In addition to asking if youth wanted a job related to science, engineering, or technology, the survey asked youth to select the career they expected to have at age 30 from a list of careers adapted from Tai et al.'s 2006 analysis. Evaluators then collapsed this list of careers in two categories: STEM-related careers (e.g., work in the medical field, engineer, farmer/rancher) and non-STEM careers (e.g., teacher, artist, lawyer, and retail). When presented with a list of careers, 42 percent of surveyed youth expected to have a STEM-related career at age 30.

Associations Between Youth Characteristics and Responses

The following section describes associations between youth characteristics, including gender and career expectations (i.e., whether youth expected to have a STEM-related career at age 30), and the following outcomes: attitudes toward science and engineering, assessment of skills, science and engineering self-efficacy, and likelihood of pursuing education related to science and engineering. Comparison analyses focused on the percentage of youth who responded most positively to survey items (i.e., “strongly agree” and “very likely”) versus all other responses.

A threshold of $p < 0.05$ was used to identify statistically significant findings, and an effect size, measured by Cramer's V , was computed to measure the strength of those findings. Conventions for educational research suggest that effect size values between 0.10 and 0.20 indicate a “small but meaningful” association, between 0.21 and 0.50 an “important” association, and 0.51 or higher an “impressive” association (Cohen, 1988; Lipsey, 1990). This report focused on findings with an effect size of at least 0.20.

Gender. Evaluators compared youth survey responses by gender on several measures and found two statistically significant differences. When responding to the statement “I like engineering,” 61 percent of boys agreed strongly, compared to 36 percent of girls ($p < 0.001$, effect size = 0.24). Similarly, a larger percentage of boys (49 percent) than girls (25 percent) agreed strongly with the statement “Someone like me can succeed in an engineering career” ($p < 0.001$, effect size = 0.24).

Career expectations. Evaluators also compared the responses of youth who reported that they expected to have a STEM-related career at age 30 and those who did not. Only one statistically significant difference was detected. Fifty-one percent of youth who reported that they expected to work in STEM-related careers strongly agreed with the statement “Someone like me can succeed in an engineering career,” compared with 32 percent of youth who reported that they expected to pursue other careers ($p < 0.05$, effect size = 0.20).

Summary of Findings

While this evaluation cannot isolate the effects of participation in 4-H Robotics clubs on youth outcomes, survey responses suggest that these clubs are serving youth whose interest in science, engineering, and technology can be sparked or intensified by participation in these informal learning activities. Although more than half of youth respondents had prior 4-H experience, 73 percent were new to robotics-related activities. Surveyed youth also reported being interested in and aware of science, technology, and engineering activities and gave positive reports of their skills and self-efficacy related to these areas. Youth respondents also reported high educational aspirations and expressed interest in pursuing STEM-related education. For example, 89 percent of youth reported being somewhat or very likely to take advanced math and science classes at their schools. Fifty-two percent of youth reported that they wanted a job related to science, engineering, or technology.

References

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