POLICY STUDIES ASSOCIATES, INC.

4-H Science Initiative: Youth Engagement, Attitudes, and Knowledge Study

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Executive Summary

In 2006 4-H National Headquarters at the U.S. Department of Agriculture and National 4-H Council introduced a new initiative aimed at increasing the number and quality of science, engineering, and technology programs that 4-H offers around the country, and increasing the number of youth involved in these programs. By engaging youth in informal science educational opportunities through the 4-H Science Initiative, the organization hopes to increase: science interest and literacy among youth, the number of youth pursuing post-secondary education in scientific fields, and the number of youth pursuing science-related careers. With the support of the Noyce Foundation, National 4-H Council has contracted with Policy Studies Associates (PSA) to evaluate the implementation of this new initiative.

Annually, nearly 6 million youth participate in 4-H, which is implemented by 106 Land-Grant Universities and Colleges (LGUs) in more than 3,000 counties as a part of the Cooperative Extension System. National leadership is provided by 4-H National Headquarters at the National Institute for Food and Agriculture, USDA, and National 4-H Council, which is the national nonprofit partner of 4-H and the Cooperative Extension System. National 4-H Council focuses on fundraising, branding, communications, and legal and fiduciary support to 4-H programs.

The National 4-H Science Evaluation Design Team created a logic model for the initiative that outlines the short- and long-term goals of the initiative. According to the logic model, programs should be designed with the following short-term youth outcomes in mind:

- Increased awareness of science
- Improved scientific skills (scientific methods) and knowledge (content areas)
- Increased awareness of opportunities to contribute to society using science
- Increased life skills

4-H selected a sample of LGUs to participate in Year 2 of the evaluation. The LGUs that participated in 2011 data collection include:

- The University of California, Davis
- Cornell University
- The University of Delaware
- Iowa State University
- The Ohio State University
- North Carolina A&T University
- Texas A&M University

This year's evaluation had three key objectives: (1) to gather program-level information about the implementation of 4-H science programs from science educators, (2) to collect information from participants about their attitudes toward science and their opinions of their 4-H Science programs, and (3) to look for any associations between youth-level data and the characteristics of the 4-H Science programs in which youth are enrolled.

In order to meet these goals, we conducted a survey of science educators leading 4-H Science programs, and a survey of youth participants. We administered the science educator survey in spring 2011 had an overall response rate of 62 percent. We administered youth surveys in a random sample of programs in late May and June 2011. We received youth surveys from 19 of the 21 programs in the sample, for a program-level response rate of 91 percent.[1] We requested that programs administer surveys to all youth between the ages of 9 and 18 who were present on the designated survey administration day.[2] The overall youth-level response rate was 66 percent. For the 19 programs that returned youth surveys, the response rate was 76 percent.

Implementation of Science Programming

Enrollment and attendance. Across science programs, enrollment ranged from two to 3,399 youth, with a median of 26 participants enrolled in each program. Reported attendance at program meetings ranged from a low of one youth to a high of 550 youth, with a median of 15 youth attending each program meeting.

Content areas. 4-H Science programs cover a range of curricular areas, including traditional 4-H content areas that have been revised to meet the criteria outlined in the Science Checklist, as well as content areas new to 4-H such as rocketry and robotics. Large and small animal science (36 percent), environmental science (23 percent), and environmental stewardship (14 percent) were among the content areas most frequently addressed in Science programs. While programs in content areas such as energy and new technologies often garner much attention, these areas actually represent a minority of 4-H Science program areas (Exhibit E1).

[1] The majority of the programs we contacted in New York and Delaware did not return youth surveys. Because including the small number of surveys we received would not be representative of those states, we excluded both states from our sample.

[2] One camp did not have the capacity to survey all youth due to the large number of participants. To alleviate the data collection burden on this program, we asked that they only survey youth in its two oldest age groups.

Exhibit E1
Content Areas of 4-H Science Programs *(n=183)*

Content Area	Percent of Programs
Environmental Science	23
Animal Science-Large Animal	19
Animal Science-Small Animal	17
Environmental Stewardship	14
Engineering	12
Physical Sciences	10
Food Science	9
Aerospace and Rocketry	9
Robotics	9
Gardening	9
Plant Science	7
Earth Science	6
Family and Consumer Sciences	5
Technology	4
Veterinary Science	4
Weather and Climate	3
Horticulture	3
Computer Technology	3
Geospatial Technology (GPS/GIS)	2

Exhibit reads: Twenty-three percent 4-H Science educators reported that their program focused on environmental science.

Curricula. The majority of science educators said that they used an established curriculum to guide their program. Eighty-four percent of all programs reported using curricula developed by 4-H or by an external organization. Among the programs that use established curricula, 77 percent reported using a curriculum developed by 4-H. Specifically, eighteen percent reported using 4-H Animal Science curricula, followed by eight percent that use Acres of Adventure (Exhibit E2).

Exhibit E2
Use of 4-H Curricula *(n=183)*

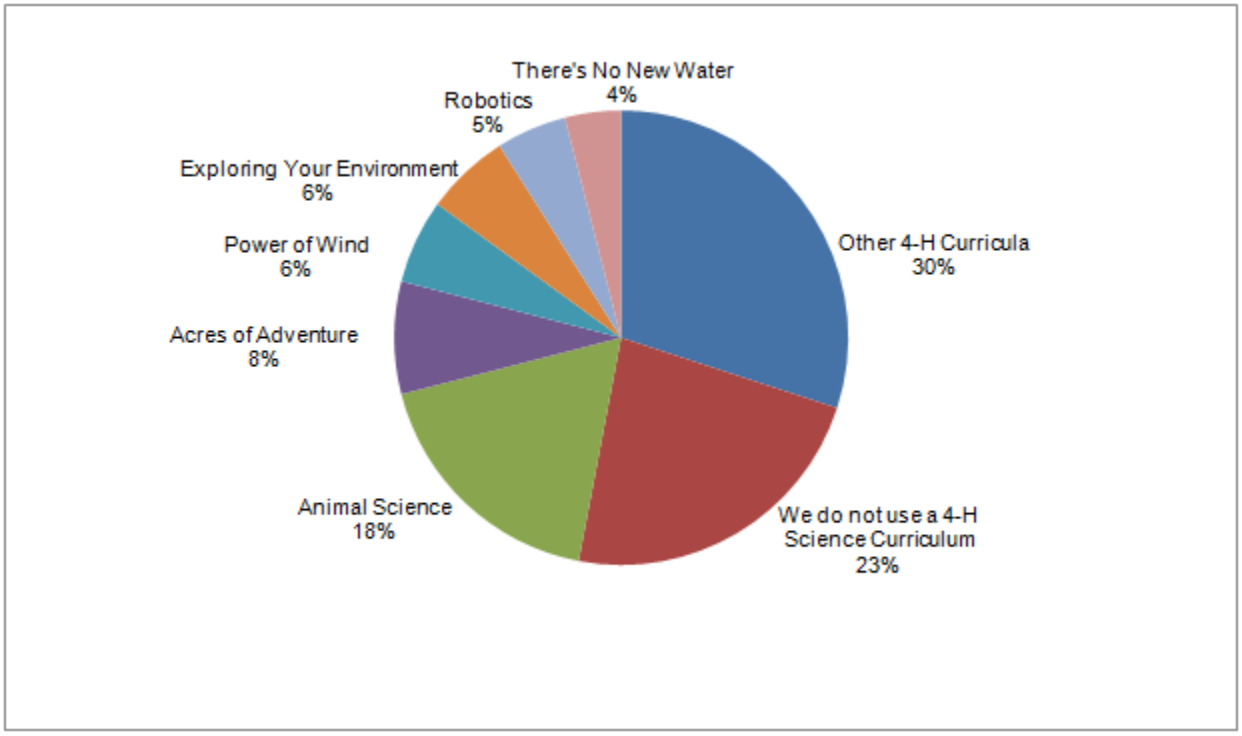

Exhibit reads: Eighteen percent of science leaders that use curricula reported using 4-H Animal Science curricula in their program. Thirty percent of science leaders use a 4-H curricula other than those listed in the survey, and 23 percent of science leaders did not use 4-H curricula in their programs.

Programming objectives. When asked to list the primary objectives of their science programs, educators largely reflected 4-H's expectations with an overwhelming majority saying that providing hands-on experiential activities (93 percent), encouraging youth to develop an interest in science (79 percent), or helping youth develop pro-social and interpersonal skills (67 percent) were major objectives of their programs. These data reflect recent research on best practices for both science education and youth development programming. Successful out-of-school programs not only promote learning content and skills, but provide youth with opportunities to develop positive relationships among themselves and between youth and program staff that are different from the relationships they build during the school day (Eccles & Gootman, 2002).

Activity offerings. Eighty-two percent of 4-H Science programs engage youth in activities that encourage them to work in teams or small groups—allowing youth to develop interpersonal skills as they master science content—and more than half of programs (61 percent) integrate activities that require youth to build or construct models to demonstrate scientific phenomena. Youth also have opportunities to practice science-related skills, including gathering data or information (52 percent), developing questions and conducting research (45 percent), and analyzing and interpreting data (43 percent).

Planning and intentionality. Eighty-one percent of educators reported using lesson plans to guide activities at some point. Of this group, less than half reported using lesson plans consistently for all program meetings (42 percent).

Characteristics of science educators. The data we collected on science educators represents both volunteers and paid staff members who lead 4-H Science programs. Many science educators leading programs held degrees in science-related fields and/or had previous experience working with youth. Eighty percent of educators reported having attained an undergraduate or graduate degree (Exhibit 9). Among educators who received a college or graduate degree, 43 percent majored in a science-related field. Thirty-four percent of respondents had previous volunteer or work experience in youth programs with a science focus.

Training and support from 4-H. A majority of science educators reported that they spoke with county and state 4-H representatives at least once per year (89 percent). Forty-three percent of science educators reported speaking with representatives several times per year, and 20 percent of science educators spoke with state and county representatives a few times per week. Ninety percent of educators agreed that the training and support they received in youth development was adequate, and 81 percent responded similarly about the trainings offered to support science content delivery.

Challenges. Some programs encountered challenges to implementing programming. A lack of funding to purchase science-related curricula (39 percent) and limited access to appropriate physical space (35 percent) were among the most frequently described challenges. Lack of volunteers with science skills or knowledge also created a challenge for science educators (22 percent).

4-H Science Participants

In Year 2 of the evaluation, we used a sampling procedure that drew a random selection of programs, surveyed all participants in the sampled programs, and achieved high response rates. We therefore believe these youth survey data are representative of 4-H Science participants in the seven evaluation states.

Demographics. We received surveys from a total of 486 youth ranging from 9 to 18 years of age. Sixty-nine percent of youth were between 9 and 12 years of age, and 31 percent were between ages 13 and 18. Females comprised the majority of the youth sample (59 percent). Sixty-one percent of youth survey respondents reported their race or ethnicity as white, 25 percent as African American, 12 percent as other, 8 percent as Hispanic/Latino, 4 percent as Native American, 3 percent as Asian-American, and 1 percent as Native Hawaiian/Other Pacific Islander. (Youth could select more than one race/ethnicity.)

Youth participation in 4-H. One of the goals of the 4-H Science Initiative is to attract new youth to 4-H through science programming. Many of the youth surveyed in this evaluation were indeed new to 4-H: 44 percent of respondents said that this was their first year.

Extent of weekly involvement. Youth spend varying amounts of time each week in their current 4-H Science programs. Roughly one-quarter of youth reported that they spend one or hour or less each week on their project (28 percent), and a quarter of youth spend between one and three hours each week (25 percent). Nearly half of respondents (47 percent) spend over three hours per week in their program. These variations may be due to different levels of youth attendance at programs, but may also reflect the variety of ways that 4-H science programming is delivered: in after-school settings, during school, in clubs during the week or on the weekends, or in a camp.

Attitudes toward science. In order to begin to build a broad set of data on interest in science among youth enrolled in informal science education programs, the Noyce Foundation worked with Dr. Cary Sneider of Portland State University, Dr. Gil Noam of Harvard University, and Foundation grantees to develop a set of youth survey items that measure youths' enthusiasm for science.

Youth responses to these items suggest that youth who attend 4-H Science programs are enthusiastic about science and eager to participate in science activities, especially in informal settings. Most participants reported that they enjoy visiting science museums or zoos, like to see how things are made, and like to participate in science projects. Youth were less likely to report that they enjoyed reading print materials about science; however, this may simply reflect youths' increasing use of electronic media and decreasing use of print materials.

National Assessment of Education Progress (NAEP) science assessment comparisons. In order to compare 4-H youths' attitudes toward science against attitudes of a representative sample of youth, we included a set of items on the survey that were taken from the NAEP Science assessments from 2005 and 2009.[3,4] The NAEP Science assessment is administered to a nationally representative sample of fourth-, eighth-, and twelfth-grade students roughly every four years and includes a set of items designed to measure respondents' interest in science.

Overall, youth in 4-H Science programming were more enthusiastic about science than their peers in the NAEP sample. While the differences between the groups are apparent, the data do not tell us why 4-H youth are more enthusiastic about science, only that there is an association between enrollment in 4-H Science and youth reports of their interest in science. This association may exist because 4-H Science programs attract youth who have a pre-existing interest in science, and therefore give more enthusiastic responses to items designed to measure their engagement in science.

Educational and career aspirations. Youth in 4-H Science programming reported having high educational aspirations. When asked how far they want to go in school, half of youth surveyed (52 percent) want to finish college, while an additional 37 percent reported that they want to get more education after completing a college degree. When we asked youth if they

[3] The NAEP science assessment did not include all science attitudinal items in both the 2005 and 2009 assessments. For information on which NAEP items were asked in which administration years, please refer to Appendix D.
[4] Some of the NAEP items were also part of the Noyce Enthusiasm for Science item set; please see Appendix B for more information.

wanted to pursue a science-related career after graduating from high school, 54 percent of youth agreed or strongly agreed.

Science skills. The vast majority (87 percent) of youth ages 9-12 reported that they can make a chart or picture to show information, while 86 percent said that they can do an experiment to answer a question. We asked youth participants ages 13 to 18 a similar set of questions about their mastery of certain science process skills. Most youth reported that they can always or usually: use the results of their investigation to answer the questions they asked (83 percent), ask a question that can be answered by collecting data (80 percent), or record data accurately (77 percent).

Program climate and benefits. When asked to select the three things they liked best about their science program, youth were most enthusiastic about the relationships they have there: 65 percent of youth said that the opportunity to spend time with their friends was their favorite part of their program, and 35 percent said that the fact that adults were caring and kind was their favorite aspect. In addition to the relationships that youth develop in their programs, youth were enthusiastic about the science learning opportunities that their programs provide: 52 percent of youth said that getting to do hands-on science activities and projects is one of their favorite things about their program.

Analysis of youth survey responses based on youth characteristics. Youth who reported attending their 4-H Science program more often and for more hours each week were more likely to rate their own life skills highly, to participate in more community science activities, and to have higher overall opinions of their science programs.

Analyses of youth survey responses revealed that boys were slightly more enthusiastic about participating in science activities than girls. However, girls were more likely to rate their program climates highly, and to give better evaluations of their own life skills.

Youth belonging to racial and ethnic groups historically underrepresented in the science fields were less likely than youth from well-represented groups to report an interest in pursuing a science career, and less likely to rate their own science and life skills highly. Youth from under-represented groups, on average, rated their program's climate and the benefits they received from attending lower than did youth from well-represented groups.

Recommendations

- Because some science educators reported facing challenges related to the affordability of science curricula, 4-H should continue to facilitate the exchange of curricular resources among states and counties, perhaps by continuing to promote online networks where educators can identify affordable curricula.

- Educators also noted that finding adequate space in which to host their 4-H Science programs was a challenge. 4-H may therefore want to collect information regarding best practices and field-tested tips to help educators identify and secure

space for their programs, and then share this information with the state- and county-level staff who can advise their educators.

- In order to support and develop girls and youth from racial and ethnic groups that are underrepresented in the science fields, 4-H should continue to seek out best practices for recruiting, engaging, and supporting these youth, and to share this information among state- and county-level leadership.

Contents

Overview of the Initiative

In 2006, 4-H National Headquarters, U.S. Department of Agriculture, and National 4-H Council introduced a new initiative aimed at increasing the number and quality of science, engineering, and technology programs that 4-H offers around the country, and increasing the number of youth involved in these programs. By engaging youth in informal science educational opportunities through the 4-H Science Initiative, the organization hopes to increase: science interest and literacy among youth, the number of youth pursuing post-secondary education in scientific fields, and the number of youth pursuing science-related careers. With the support of the Noyce Foundation, National 4-H Council has contracted with Policy Studies Associates (PSA) to evaluate the implementation of this new initiative.

Annually, nearly 6 million youth participate in 4-H, which is implemented by 106 Land-Grant Universities and Colleges (LGUs) in more than 3,000 counties as a part of the Cooperative Extension System. National leadership is provided by 4-H National Headquarters at the National Institute for Food and Agriculture, USDA, and National 4-H Council, which is the national nonprofit partner of 4-H and the Cooperative Extension System. National 4-H Council focuses on fundraising, branding, communications, and legal and fiduciary support to 4-H programs.

4-H has set an enrollment goal: by the end of 2013, 1 million youth who have never before been in 4-H will enroll in 4-H Science programs. In order to meet this goal, 4-H has sought since 2006 to increase its capacity and infrastructure for providing 4-H Science programming. As part of this effort, 4-H formed the National 4-H Science Leadership Team, which consists of national, state and county-level 4-H professionals. In addition, Science Liaisons have been appointed at LGUs around the country to help implement programs and to recruit youth into these programs.

The National 4-H Science Evaluation Design Team created a logic model for the initiative that outlines the short- and long-term goals of the initiative. According to the logic model, programs should be designed with the following short-term youth outcomes in mind:

- Increased awareness of science
- Improved scientific skills (scientific methods) and knowledge (content areas)
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Evaluation Methodology

The goals of this evaluation are to describe characteristics of 4-H Science programs in selected states, and to understand the attitudes youth in these programs hold towards science. This report is based on the results of two surveys: a survey of science educators leading 4-H Science programs, and a survey of youth in a sample of programs.

This section of the report details the approach the evaluation team used to document and assess 4-H Science programs in the states selected to participate in this second year of the evaluation.

Participating Land Grant Universities

4-H selected a sample of nine LGUs to participate in Year 2 of the evaluation. However, two LGUs were removed from the sample: one LGU reported that it did not have staff available to facilitate data collection, and another LGU did not participate because the evaluation team did not receive IRB approval to conduct research there until the evaluation's data collection window had passed. The seven LGUs that participated in 2011 data collection include:

- The University of California, Davis
- Cornell University
- The University of Delaware
- Iowa State University
- The Ohio State University
- North Carolina A&T University
- Texas A&M University

Identifying 4-H Science Programs

While many 4-H clubs, camps, after-school programs, and school enrichment programs address content areas that are related to science—for example, embryology or food and consumer science—not all science-related 4-H programming is considered to be part of the 4-H Science Initiative. 4-H has therefore developed tools for state and county staff to use in assessing which of their science-related programs should be considered a part of 4-H Science.

4-H Science Checklist. At the onset of the 4-H Science Initiative, 4-H developed a set of expectations, referred to as the 4-H Science Checklist, which outlines what characteristics programs must meet to be considered part of the Science Initiative's national evaluation. The 4-H Science Checklist requires that programs: (1) be based on National Science Education Standards, (2) develop participants' science-related skills and abilities, (3) use positive youth development practices, (4) are led by staff who are well-trained in youth development and appropriate content, (5) use an experiential approach to learning, (6) foster creativity and curiosity among participants, and (7) address outcomes on the 4-H Science Logic Model.[5] 4-H programming that meets the Checklist criteria is labeled as "Science Ready."

ACCESS 4-H. Currently, information on which 4-H programs qualify as Science Ready is tracked in different ways by different states. However, 4-H has implemented the use of a database called ACCESS 4-H that is designed to track information about 4-H programming and participants. Those LGUs that adopt the system are able to enter and track data about all of their

[5] The 4-H Science Checklist can be found in Appendix A.

4-H programs, including a program's Science Ready status. Once this information is captured in ACCESS, 4-H will be able to readily identify programs that qualify as Science Ready, and analyze implementation and participation data from those programs. Although we did not use ACCESS 4-H data in Year 2, we expect to utilize data from the system for evaluation activities in Year 3.

Requesting Science Ready program information from state leadership. In the future, states that use ACCESS 4-H will be able to easily download information on which of their science programs meet the standards set forth in the Checklist. At this point, in order to establish a group of Science Ready programs to participate in Year 2 evaluation activities, we asked state-level leadership to identify Science Ready programs in their states. Using this information, we contacted the lead staff members or volunteers in these programs and began administration of the evaluation's two Year 2 surveys: the survey of science educators, and the Youth Engagement, Attitudes, and Knowledge survey.

Survey of 4-H Science Educators

In order to learn more about the goals of 4-H Science programs and the types of activities they feature, we conducted a survey of 4-H Science educators. Using the lists of 4-H Science Ready programs generated by state-level leadership, we contacted the extension educators, staff members, and volunteers who serve as the leader of a 4-H Science Ready program and asked them to complete a survey. The survey asked leaders to verify that their program was science-focused, and to provide information about its goals, its daily activities, and the content areas it addressed. As shown in Exhibit 1, the overall response rate for the survey of 4-H Science educators was 62 percent; individual states' response rates ranged from a low of 35 percent in Delaware to a high of 100 percent in North Carolina.

Exhibit 1
Science Educator Survey Response Rates *(n=182)*

LGU	Response Rate
North Carolina A&T University *(n=11)*	100
The Ohio State University *(n=35)*	75
Texas A&M University *(n=11)*	73
Iowa State University *(n=14)*	67
The University of California, Davis *(n=37)*	65
Cornell University *(n=67)*	55
The University of Delaware *(n=7)*	35
Total	*62*

Exhibit reads: One hundred percent of 4-H educators leading Science Ready programs in North Carolina responded to the survey.

In Year 1 of the evaluation we surveyed county-level 4-H staff and asked them to provide information about the Science Ready programs in their counties. Because of a low response rate to that survey, the programs we selected from that pool to administer the participant survey were not representative of the 4-H Science Initiative overall. In Year 2 we worked with a smaller number of LGUs, and put renewed emphasis on achieving high response rates in our follow-up efforts in order to increase the representativeness of our final datasets.

Survey of Youth in Science Ready Programming

***Youth survey design*.** As part of the evaluation of Science programs, PSA worked with the 4-H Science Instrument Design Team: Melissa Cater, Mary Arnold, Lisa Bouillion Diaz, Katherine Heck, June Mead, Beverly Spears, Ben Silliman, and Maureen Mulroy, and with Jill Walahoski and Suzanne LeMenestrel to develop the 4-H Science Youth Engagement, Attitudes and Knowledge (YEAK) survey in Year 1 of the evaluation. PSA first administered the survey on a national scale in winter 2009 (Year 1), and conducted a second national administration in late spring/early summer 2011 (Year 2). The YEAK survey serves to address the following questions about the youth in the survey sample:

- What are the characteristics of the youth involved in Science Ready programming?
- What are participants' attitudes toward the scientific fields? Do participants aspire to pursue career opportunities in science-related fields?
- What level of education do participants want to achieve?
- To what extent are participants engaged in both formal and informal science learning? Do participants pursue science leadership opportunities?
- What science-related skills, abilities, and knowledge do participants have?
- What factors, if any, are associated with participants' engagement, attitudes, and knowledge of science?

Noyce Enthusiasm for Science survey items. In July 2010, The Noyce Foundation convened a group of its out-of-school time grantees to discuss the potential of streamlining their evaluation approaches in order to develop a common set of evaluative measures across the grantee group. Led by Dr. Cary Sneider and Dr. Gil Noam, the group identified a set of youth and staff survey items—referred to as the Noyce Enthusiasm for Science items—which all grantees committed to administering during their 2010-11 data collection efforts.[6]

Sampling approach. In order to generate youth-level data that would be representative of all 4-H Science youth in the states participating in the evaluation, we developed a program-

[6] The Noyce Enthusiasm for Science survey items are flagged in the youth and science educator surveys, which can be found in Appendix B.

level random sampling process for our youth survey administration. The objective of administering surveys in a random sample of programs was to ensure that the programs we selected were representative of the larger population of 4-H Science programs in those states. By randomly selecting programs and not simply asking 4-H leadership to name programs for us to survey, we ensured that typical 4-H Science Ready programs were included, and that our sample was not limited to high-visibility or high-functioning programs.

Using the sampling frame created through our administration of the 4-H Science educator survey, we selected a sample of Science Ready programs operating in May and June of 2011 in which to administer the YEAK survey to participants. We generated a random sample of five programs operating in May or June 2011 in each state in order to ensure that our sample would be representative. For those LGUs that had five or fewer Science Ready programs operating in May or June, we included all programs in our sample.

Program-level response rates. We administered youth surveys in late May and June 2011. We received surveys from 19 of the 21 programs in the sample, for a program-level response rate of 91 percent.[7]

Youth-level sample. We requested that programs administer surveys to all youth between the ages of 9 and 18 who were present on the designated survey administration day.[8] In order to ensure that our sample would be representative, we emphasized the importance of administering surveys to all youth, regardless of their science abilities or engagement in the program. The overall youth-level response rate was 66 percent. For the 19 programs that returned youth surveys, the response rate was 76 percent.

Exhibit 2
Program- and Youth-Level Response Rates

LGU	Number of programs surveyed	Programs returning surveys	Number of youth surveyed	Completed youth surveys	Youth-level response rate *(in percents)*
The University of California, Davis	5	5	94	59	63
Iowa State University	3	3	50	43	86
The Ohio State University	4	3	283	211	75
North Carolina A&T University	4	3	194	89	46
Texas A&M University	5	5	118	84	71
Total	*21*	*19*	*739*	*486*	*66*

Exhibit reads: Of the five University of California, Davis 4-H Science programs that were sent surveys, five returned surveys. Of the 94 youth who were surveyed in California, 59 completed surveys, for a response rate of 63 percent.

Generalizeability of data. The evaluation team's efforts to identify Science Ready programming by working with state leadership and then surveying Science educators helped to

[7] The majority of the programs we contacted in New York and Delaware did not return youth surveys; because their data would not have been representative, we excluded both states' data from our analyses.
[8] One camp did not have the capacity to survey all youth due to the large number of participants. To alleviate the data collection burden on this program, we asked that they only survey youth in its two oldest age groups.

ensure that we developed a robust understanding of the Science Ready programming offered in each study state. While the response rate to the Science educator survey was slightly lower than expected, this 62 percent response rate marked a great improvement over Year 1.

By drawing a random sample of programs to survey, and then achieving a youth-level response rate of 76 percent in programs that returned surveys, we believe that our data are largely representative and that our findings are generalizeable to the larger 4-H Science population in the states participating in the evaluation.[9]

Statistical Tests Employed

This report provides both descriptive statistics and analyses of the relationships between various items from the youth survey. We used a threshold of $p<0.05$ to identify statistically significant findings, and then computed an effect size to measure the magnitude or 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 focuses on findings with an effect size of at least 0.20; comparisons or associations below this threshold were considered too weak to warrant reporting.

Organization of the Report

The first section of this report describes findings from the survey of all 4-H Science educators in the seven states participating in the evaluation, the second section presents data from the YEAK survey, and the final sections summarize this evaluation's findings and present recommendations.

Implementation of Science Programming

In this section we review findings from the survey of 4-H Science educators in all seven states originally selected to be part of this year's evaluation. We asked educators to provide information ranging from enrollment to program activity offerings to challenges they face in implementing their science programs.

Overview of Program Characteristics

Recruitment. One of 4-H's goals for the Science Initiative is to attract youth who have never before been involved in the organization by sparking their interest through participation in a science program. In order to attract participants, science educators reported using various

[9] While there is not a specific response rate that, if achieved, guarantees the risk of non-response error, a response rate near 70 percent is typically considered acceptable.

methods to share information about their programs and encourage youth to enroll. While more than half of the science educators reported that youth typically find out about their science programs through word-of-mouth (53 percent), many also employed various efforts to get word of their programs out to youth. Forty-eight percent reported that youth learn about their programs through their schools, and 45 percent of programs reported that participants also learn about their programs through participating in other 4-H programs. In addition to these methods, educators also said that they advertise their programs through the 4-H website (29 percent), and by distributing flyers throughout their communities (28 percent).

Programming type. Programming occurred at varying times depending on the delivery mode and the nature of the science program, with after-school being the most popular meeting time. Educators could select more than one meeting time in their response, and just under half of educators indicated that their programs met during multiple meeting times. After-school was the most popular meeting time, with more than half of science educators (54 percent) indicating that their programs met after school. Summer was also a popular meeting time for programs, with 41 percent of educators indicating that their programs occurred during the summer. Programs also met on weekends (33 percent) and during the school day (27 percent).

Enrollment and attendance. Across science programs, enrollment ranged from two to 3,399 youth, with a median of 26 participants enrolled in each program. Reported attendance at program meetings ranged from a low of one youth to a high of 550 youth, with a median of 15 youth attending each program meeting. These attendance figures include data from both small clubs and bigger programs in which large numbers of youth might participate for one day at a large-scale, state-wide event, or as part of a school enrichment program that takes place in multiple classrooms and schools.

Youth served. Science programs served youth between the ages of 5 and 18. About two-thirds of programs served youth in the middle of this age range (ages 9 to 12), as seen in Exhibit 3.

Exhibit 3
Ages Served by 4-H Science Programs *(n=180)*

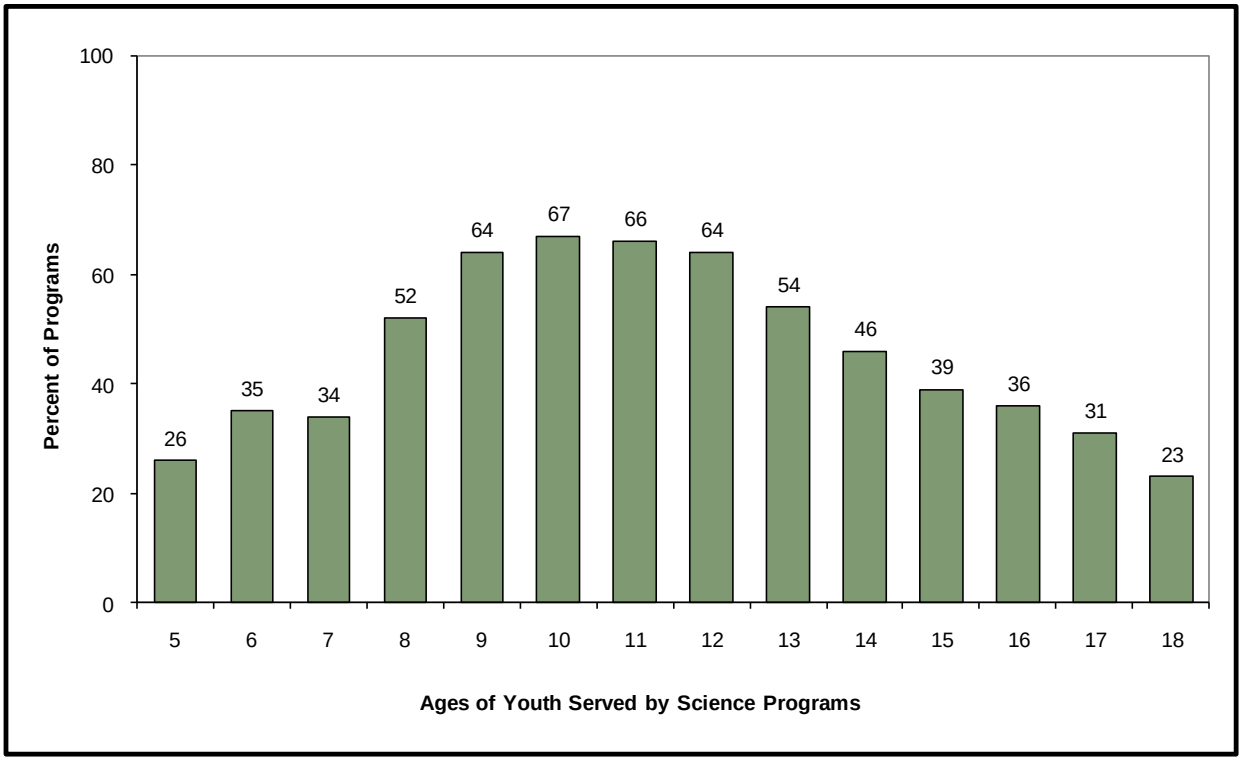

Exhibit reads: Twenty-six percent of science educators reported that their 4-H Science program serves five-year-olds. (Educators could select multiple ages.)

Content areas. 4-H Science programs cover a range of curricular areas, including traditional 4-H content areas that have been revised to meet the criteria outlined in the 4-H Science Checklist, as well as content areas new to 4-H such as rocketry and robotics. Large and small animal science (36 percent), environmental science (23 percent), and environmental stewardship (14 percent) were among the content areas most frequently addressed in Science programs (Exhibit 4).

Exhibit 4
Content Areas of 4-H Science Programs *(n=183)*

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Food Science	9
Aerospace and Rocketry	9
Robotics	9
Gardening	9
Plant Science	7
Earth Science	6
Family and Consumer Sciences	5
Technology	4
Veterinary Science	4
Weather and Climate	3
Horticulture	3
Computer Technology	3
Geospatial Technology (GPS/GIS)	2

Exhibit reads: Twenty-three percent of 4-H Science educators reported that their program focused on environmental science.

Curricula. The majority of science educators said that they used an established curriculum to guide their program. Eighty-four percent of all programs reported using curricula developed by 4-H or by an external organization. Among the programs that use established curricula, 77 percent reported using a curriculum developed by 4-H. Specifically, 18 percent reported using 4-H Animal Science curricula, followed by 8 percent that use Acres of Adventure (Exhibit 5). Thirty percent of these programs reported using other 4-H curricula, including Youth Experiences in Science, food science curricula, and rocketry curricula.

Exhibit 5
Use of 4-H Curricula *(n=183)*

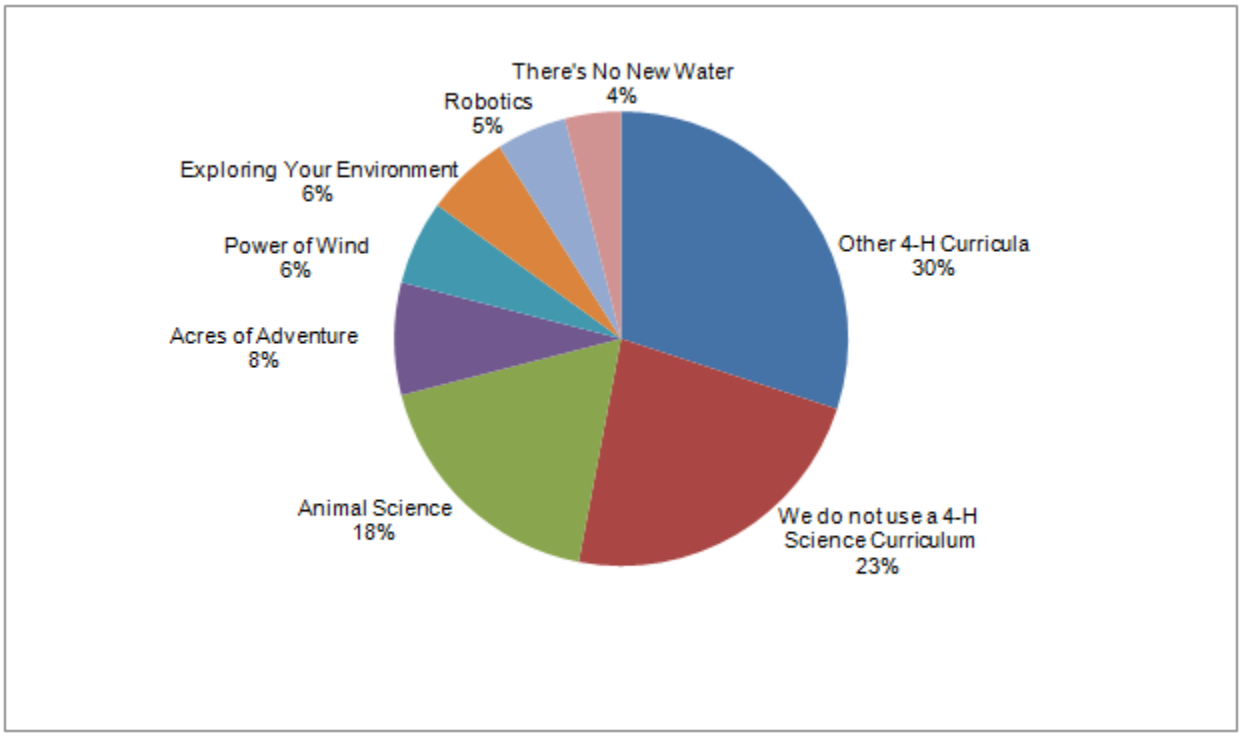

Exhibit reads: Eighteen percent of science leaders that use curricula reported using 4-H Animal Science curricula in their program. Thirty percent of science leaders use a 4-H curricula other than those listed in the survey, and 23 percent of science leaders did not use 4-H curricula in their programs.

In addition to the programs that use a 4-H curriculum, 34 percent of programs said that they used curricula developed by organizations other than 4-H. These organizations included universities, state and federal agencies, and First Lego League.

Programming Objectives and Activities

Current research on out-of-school time programming suggests that these programs should be well organized, and feature engaging activities that have specific and clear learning goals for youth (Eccles & Gootman, 2002; McLaughlin, 2000; Noam, 2008; Vandell et al., 2006). Recent trends in school-day science education priorities also acknowledge the importance of active, experiential learning. In July 2011, the National Research Council published a Conceptual Framework for K-12 Science Education Standards. In the framework, the committee suggests that K-12 education can learn from best practices in informal science education by offering hands-on learning opportunities (NRC, 2011). Providing youth with the opportunity to practice science, the committee states, is critical to building scientific understanding: "Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements—knowledge and practice—are essential."

Successful out-of-school programs not only promote learning content and skills but also provide youth with opportunities to develop positive relationships among themselves and between youth and program staff that are different from the relationships they build during the school day (Eccles & Gootman, 2002). Durlak and Weissberg's meta analysis of youth program evaluations (2007) also suggests that by employing staff who show positive affect toward youth and who engage personally with youth, programs can actually improve youth social and developmental outcomes.

In line with research on youth development and informal science programming, the 4-H Science Checklist outlines 4-H's expectation that 4-H Science programs provide skill-driven, experiential learning opportunities, as well as a positive youth development context in which participants are able to develop relationships with other youth and with program staff and volunteers.

In order to better understand the nature of the activities offered as part of 4-H Science programs, the evaluation team asked educators to report on their program's goals, and the frequency with which youth participate in various activities and program opportunities.

Programming objectives. When asked to list the primary objectives of their science programs, educators largely reflected 4-H's expectations with an overwhelming majority saying that: providing hands-on experiential activities (94 percent), encouraging youth to develop an interest in science (79 percent), or helping youth develop pro-social and interpersonal skills (67 percent) were major objectives of their programs (Exhibit 6).

Exhibit 6
Major Program Objectives *(n=184)*

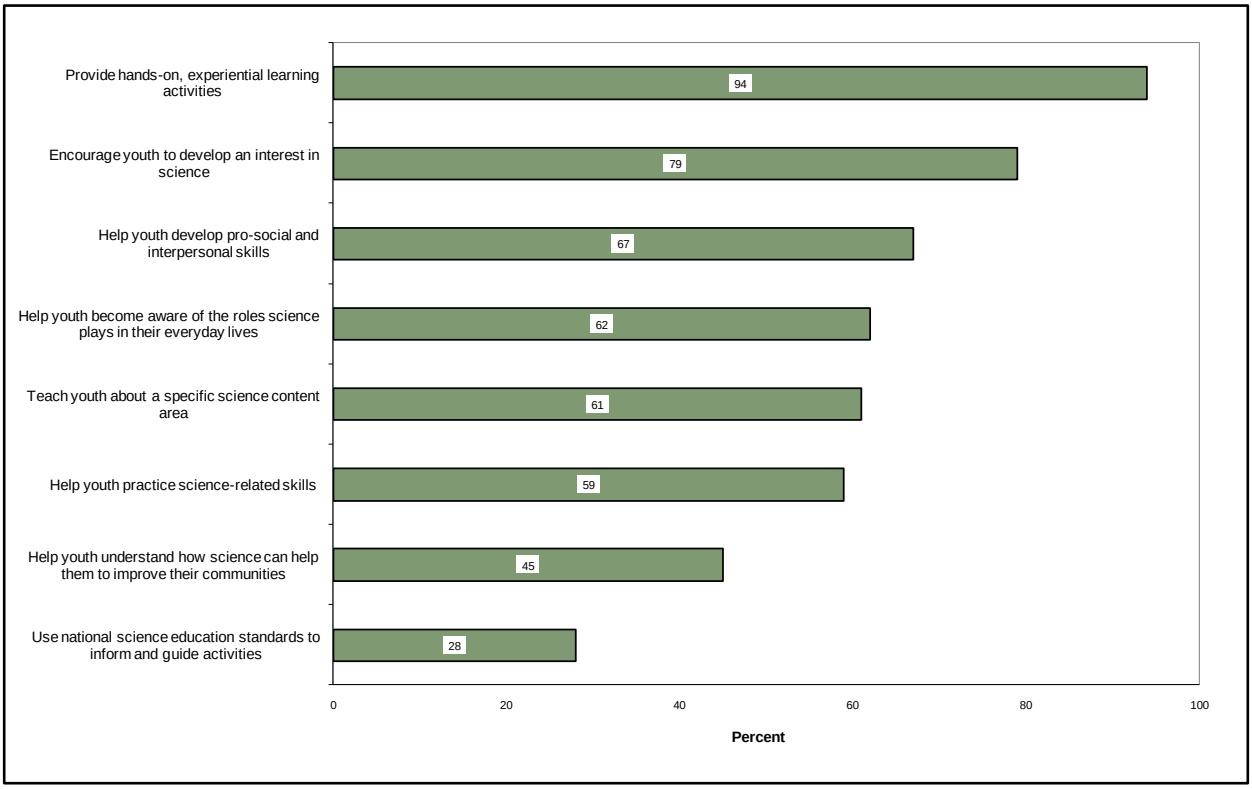

Exhibit reads: Ninety-four percent of educators reported that a goal of their program is to provide hands-on, experiential learning opportunities.

More than half of all science educators also reported that their programs aim to: help youth become aware of the roles science plays in their everyday lives (62 percent), teach youth about a specific science content area (61 percent), and help youth practice science-related skills (59 percent).

Activity offerings. When asked to report on the frequency with which youth participated in certain types of learning activities, science educators reported that youth not only practiced science skills such as gathering and interpreting data, but also had many opportunities to work in groups and use teamwork to solve problems. This focus on communication and interpersonal skills reflects the National Research Council's Committee on Conceptual Framework for K-12 Science Education Standards' suggestion that science education reflect that "science is fundamentally a social enterprise, and scientific knowledge advances through collaboration and the context of a social system with well developed norms."

As shown in Exhibit 7, 82 percent of 4-H Science programs engage youth in activities that encourage them to work in teams or small groups—allowing youth to develop interpersonal skills as they master science content—and 61 percent of programs integrate activities that require youth to build or construct models to demonstrate scientific phenomena. Youth also have opportunities to practice science-related skills, including gathering data or information (52

percent), developing questions and conducting research (45 percent), and analyzing and interpreting data (43 percent).

Exhibit 7
Program Activities Occurring at Every or Nearly Every Meeting,
In Percents *(n=182)*

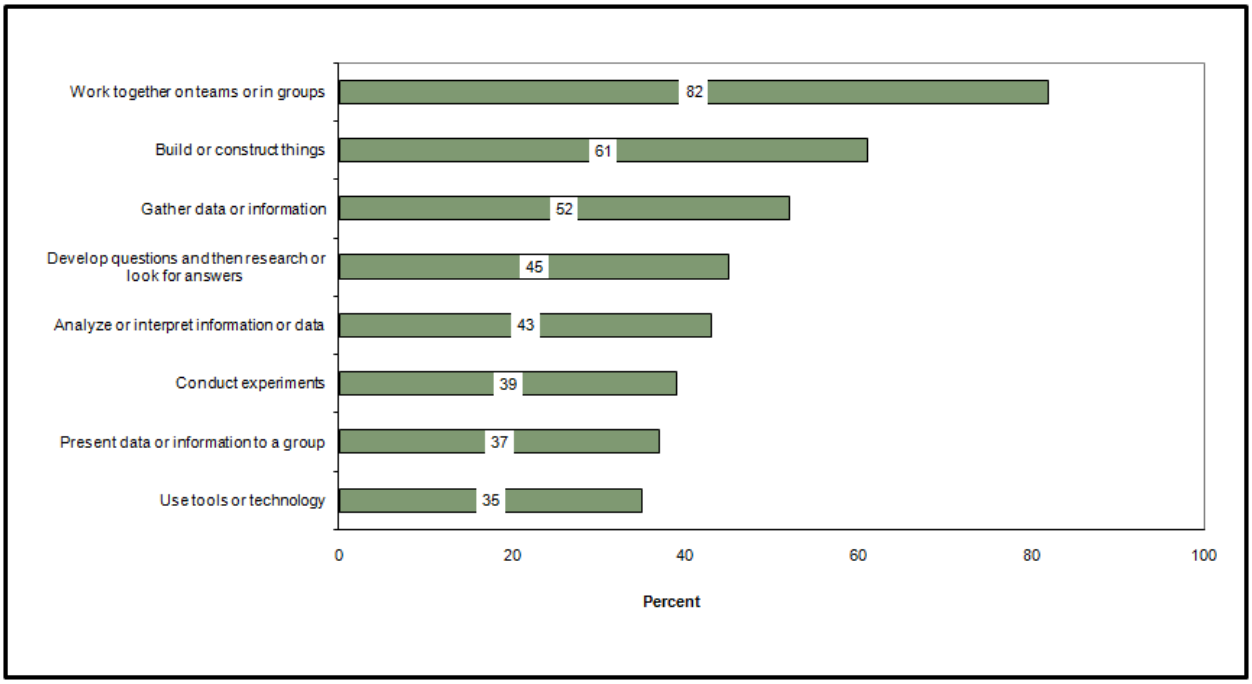

Exhibit reads: Eighty-two percent of programs engage youth in activities in which they work together on teams on in groups at every or at nearly every meeting.

Eighty-nine percent of science educators reported that they engage youth in activities that allow them to learn about careers that use science, and 81 percent of science educators reported using activities that involve meeting with adults who work in science-related fields (Exhibit 8). Providing youth with opportunities to learn about careers in science is a practice in line with current research that suggests that exposing youth to science early on can affect their education and career choices later in life (Tai, Liu, Maltese, & Fan, 2006).

Exhibit 8
Activity Offerings that Feature Information about Science-Related Careers or Educational Pathways *(n=182)*

Content Area	Percent of Programs
Learn about careers that use science	89
Meet with adults who work in science-related fields	81
Learn about educational choices that youth must make to pursue a science-related career	80
Take field trips to see how science is used in real life	68

Exhibit reads: Eighty-nine percent of programs engage youth in activities that allow them to learn about careers that use science.

Planning and intentionality. Eighty-one percent of educators reported using lesson plans to guide activities at some point; of this group, less than half reported using lesson plans consistently for all program meetings (42 percent).

Program Volunteers and Staff

Having knowledgeable, caring, and capable staff members is central to delivering high quality out-of-school time programming (Durlak & Weissberg, 2007; Russell, Mielke, & Reisner, 2009). In this section we describe the characteristics of staff members leading 4-H Science programming, as provided by science educator survey respondents.

Characteristics of science educators. The data we collected on science educators represents both volunteers and paid staff members who lead 4-H Science programs. Many science educators leading programs held degrees in science-related fields and/or had previous experience working with youth. Eighty percent of educators reported having attained an undergraduate or graduate degree (Exhibit 9). Among educators who received a college or graduate degree, 43 percent majored in a science-related field. Thirty-five percent of respondents had previous volunteer or work experience in youth programs with a science focus.[10]

[10] Many of the staff background questions were also part of a common set of staff measures used by Noyce grantees. Please see Appendix B for a complete copy of the staff survey instrument, which notes which items are part of the Noyce staff set.

Exhibit 9
Science Educator Background *(n=183)*

		Percent of Science Educators
Age	21 years or older	97
	20 years-old or younger	3
Gender	Female	84
	Male	16
Education	Graduate Degree	50
	Undergraduate Degree	30
	Two-Year College Completion	10
	Some college	8
	HS diploma or GED	2
Has a Science, Technology, Engineering, or Mathematics major		43
Has previous experience in a Science, Technology, Engineering, or Mathematics-focused youth program		35

Exhibit reads: Ninety-seven percent of science educators who lead programs are 21 years old or older.

Program staffing. Aside from the primary science educator, 75 percent of all science programs involved additional volunteers or staff. Of these programs, 67 percent involved adult volunteers with science backgrounds, 65 percent involved parent volunteers, 47 percent involved adult volunteer without science backgrounds, 33 percent involved high school students, and 18 percent involved college students. Programs often used a mixture of staff and volunteers with different backgrounds and qualifications.

Of the science educators reporting additional personnel, 71 percent reported that their programs involved 10 or fewer additional volunteers or staff. Thirty-six percent had just one or two additional volunteers or staff. Fourteen percent of science educators reported involving between 11 and 20 additional staff or volunteers.

Program Supports

Science educators rely on several supports to maintain program operation, including opportunities to discuss science programming with county- and state-level 4-H leaders, training and professional development opportunities, and financial contributions.

Training and support from 4-H. A majority of science educators reported that they spoke with county and state 4-H representatives at least once per year (89 percent). Forty-three percent of science educators reported speaking with representatives several times per year, and 20 percent of science educators spoke with state and county representatives a few times per week.

4-H works to provide training opportunities for volunteers and staff in positive youth development, science content areas, and instructional methods that support program quality and activity delivery. When asked about the adequacy of these trainings, survey respondents were overwhelmingly positive: 90 percent of educators agreed that the training and support they received in youth development has been adequate, and 80 percent responded similarly about the trainings offered to support science content delivery.

Exhibit 10
Science Educators Who Agree That Their Training Has Been Adequate, In Percents *(n=180)*

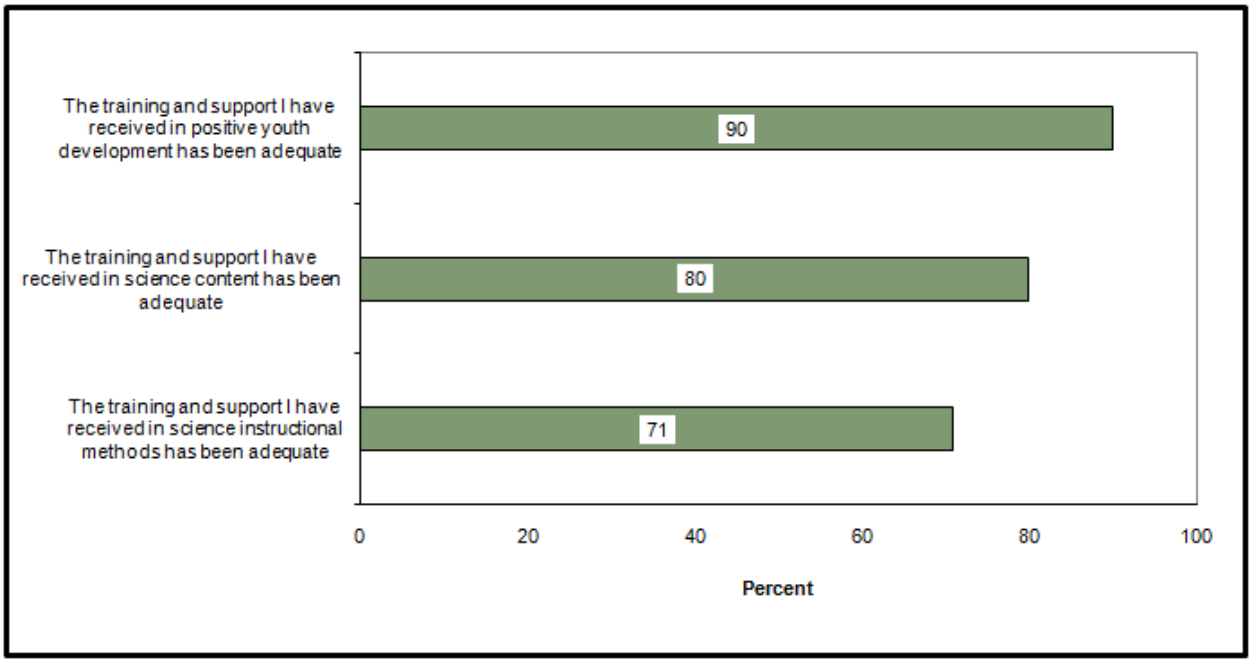

Exhibit reads: Ninety percent of respondents agreed that they have received adequate training in positive youth development.

Financial and in-kind supports. Because many 4-H Science programs are led by volunteers and have limited, if any, operating budgets, science educators reported receiving various financial and in-kind contributions to support program operation. While half receive support from 4-H, science educators also reported supporting program operations by collecting dues (40 percent), using personal funds and resources (40 percent), or writing grants or holding fundraisers (35 percent).

Challenges

Some programs encountered challenges to implementing programming. A lack of funding to purchase science-related curricula (39 percent) and limited access to appropriate physical space (35 percent) were among the most frequently described challenges. Lack of volunteers with science skills or knowledge also created a challenge for science educators (22 percent).

Exhibit 11
Major Challenges to Program Implementation *(n=179)*

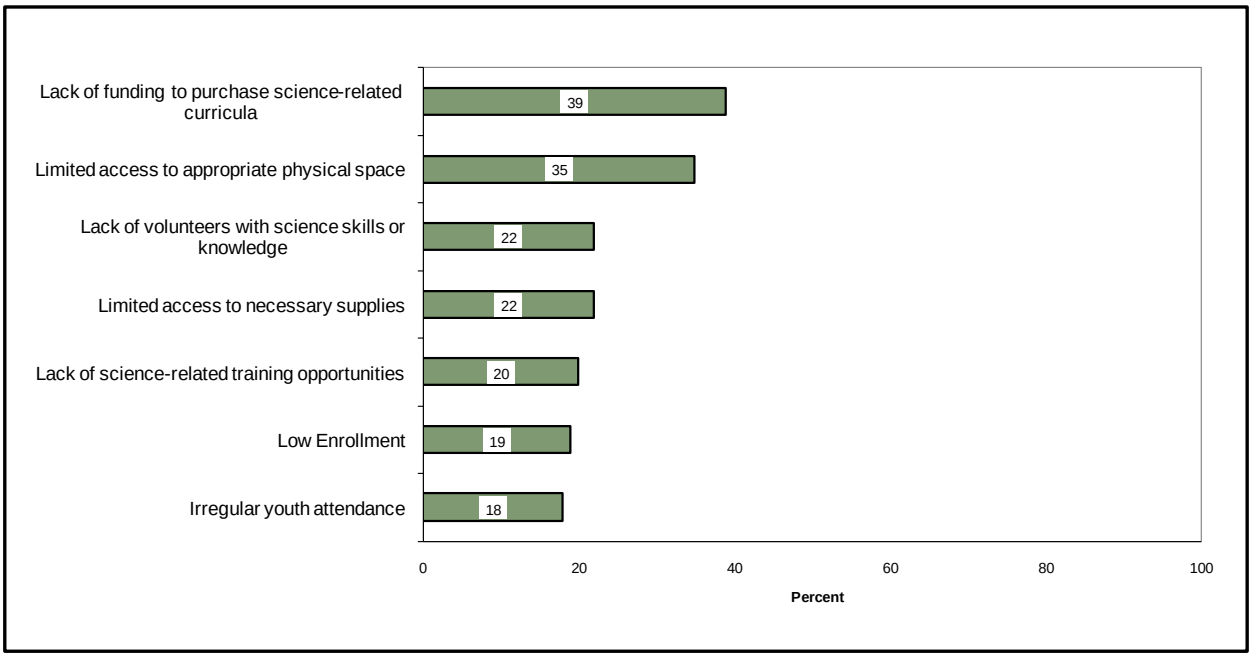

Exhibit reads: Thirty-nine percent of program leaders view lack of funding to purchase science-related curricula as a major challenge to implementing programming.

4-H Science Participants

In the section that follows, we present demographic information on the youth who completed YEAK surveys, describe their skills and attitudes toward and skills in science, and compare the attitudes held by 4-H Science participants to those of a national sample of youth. We also present comparisons among 4-H Science participants based on gender, race/ethnicity, and exposure to 4-H Science programming.

As described in the introduction, because we used a sampling procedure that drew a random selection of programs, surveyed all participants in the sampled programs, and achieved high response rates, we believe that these youth survey data are representative of 4-H Science participants in the seven evaluation states.

Because the youth sampling procedure used for this year's report was different than the procedure used in Year 1, and because the LGUs involved in the evaluation differed across Year 1 and Year 2, we do not make any comparisons between Year 1 and Year 2 youth survey data. We do, however, provide a narrative description of similarities and differences across Year 1 and Year 2 findings in Appendix E.

Demographics

We received surveys from a total of 486 youth ranging from 9 to 18 years of age. Sixty-nine percent of youth were between 9 and 12 years of age, and 31 percent were between ages 13 and 18. Females comprised the majority of the youth sample (59 percent). Sixty-one percent of youth survey respondents reported their race or ethnicity as white, 25 percent as African American, 12 percent as other, 8 percent as Hispanic/Latino, 4 percent as Native American, 3 percent as Asian-American, and 1 percent as Native Hawaiian/Other Pacific Islander. (Youth could select more than one race/ethnicity.)

More than three-quarters (81 percent) of youth reported they attend public school. Ten percent said they were home schooled, six percent attended a religious school, and three percent attended private school.

Exposure to 4-H

In formal school-based learning environments, rote learning often takes precedent over inquiry and exploration as teachers and schools react to the demands of assessments that prioritize memorization (President's Council of Advisors on Science and Technology, 2010). Informal settings, such as after-school programs, clubs, and camps, can give youth the opportunity to learn science content and process skills in engaging and interactive ways. Such environments also have the potential to provide rich youth development experiences.

In order to understand the experiences that surveyed youth have had in 4-H and the background they bring to their current 4-H Science program, we asked youth to report their previous involvement with 4-H and the extent of their involvement with their current program.

Youth experience in 4-H. One of the goals of the 4-H Science Initiative is to attract new youth to 4-H through science programming. Many of the youth surveyed in this evaluation were indeed new to 4-H: 44 percent of respondents said that this was their first year. There was also a large group of youth with more extensive 4-H experience: 17 percent of respondents were in their second year, and 39 percent had been in 4-H for three or more years. Thirty-six percent of youth reported that they are or have been involved in another science-related 4-H program other than their current program.

When asked for how long they have been participating in their current science project or program, 37 percent of youth said they have been in the program for one month or less. Eleven percent have been participating for 2 to 4 months, 11 percent for 5 to 7 months, and 41 percent for 8 months or more.

Extent of weekly involvement. Participants spend varying amounts of time each week in their current 4-H Science programs. Roughly one-quarter of youth reported that they spend one hour or less each week on their project (28 percent), and a quarter spend between one and three hours each week (25 percent). Nearly half of respondents (47 percent) spend more than three hours per week in their program. These variations may be due to different levels of youth attendance at programs, but may also reflect the variety of ways that 4-H science programming is

delivered: in after-school settings, during school, in clubs during the week or on the weekends, or in a camp.

Delivery mode. Because 4-H offers several different programming models in which youth can participate, we asked youth to indicate in which types of 4-H programs they participate. Youth reported participation in a range of 4-H programming, with close to half (46 percent) involved in clubs, 42 percent in local fairs and events, and 41 percent in at-home projects (Exhibit 12). Over half (56 percent) of youth reported participating in more than one type of 4-H program.

Exhibit 12
Youth Involvement in 4-H Programming (n=400)

Program Type	Percent of Respondents
Clubs	46
Local fairs/events	42
Working on my projects at home	41
Camps	40
After-school programs	33
Community service projects	31

Exhibit reads: Forty-six percent of youth are involved in 4-H clubs.
Note: Percentages do not add to 100 because youth could select more than one type of programming.

Attitudes Toward Science

One of the goals of the 4-H Science Initiative is to increase participants' interest in science in school, in their personal lives, and in their communities. The youth survey included a series of questions intended to gauge respondents' enthusiasm for science not only as an academic subject but also as a subject that touches their everyday lives.

Noyce Enthusiasm for Science youth survey items. In order to begin to build a broad set of data on interest in science among youth enrolled in informal science education programs, the Noyce Foundation worked with Dr. Cary Sneider of Portland State University, Dr. Gil Noam of Harvard University, and Foundation grantees to develop a set of youth survey items, collectively referred to as the Noyce Enthusiasm for Science items. The Noyce items were adapted from various science-related youth survey instruments, and their psychometric properties were tested by researchers at Harvard's Program in Education, Afterschool, and Resiliency (PEAR). We included these items on the 2011 version of the YEAK survey.

Youth responses to the Noyce Enthusiasm for Science survey items suggest that youth who attend 4-H Science programs are highly engaged in science-related activities, and are eager to participate in science activities, especially in informal settings. Most participants reported that they enjoy visiting science museums or zoos, like to see how things are made, and like to participate in science projects. Youth were less likely to report that they enjoyed reading print

materials about science; however, this may simply reflect participants' increasing use of electronic media and decreasing use of print materials (Exhibit 13).

Exhibit 13
Noyce Enthusiasm for Science Survey Items,
In Percents *(n=389)*

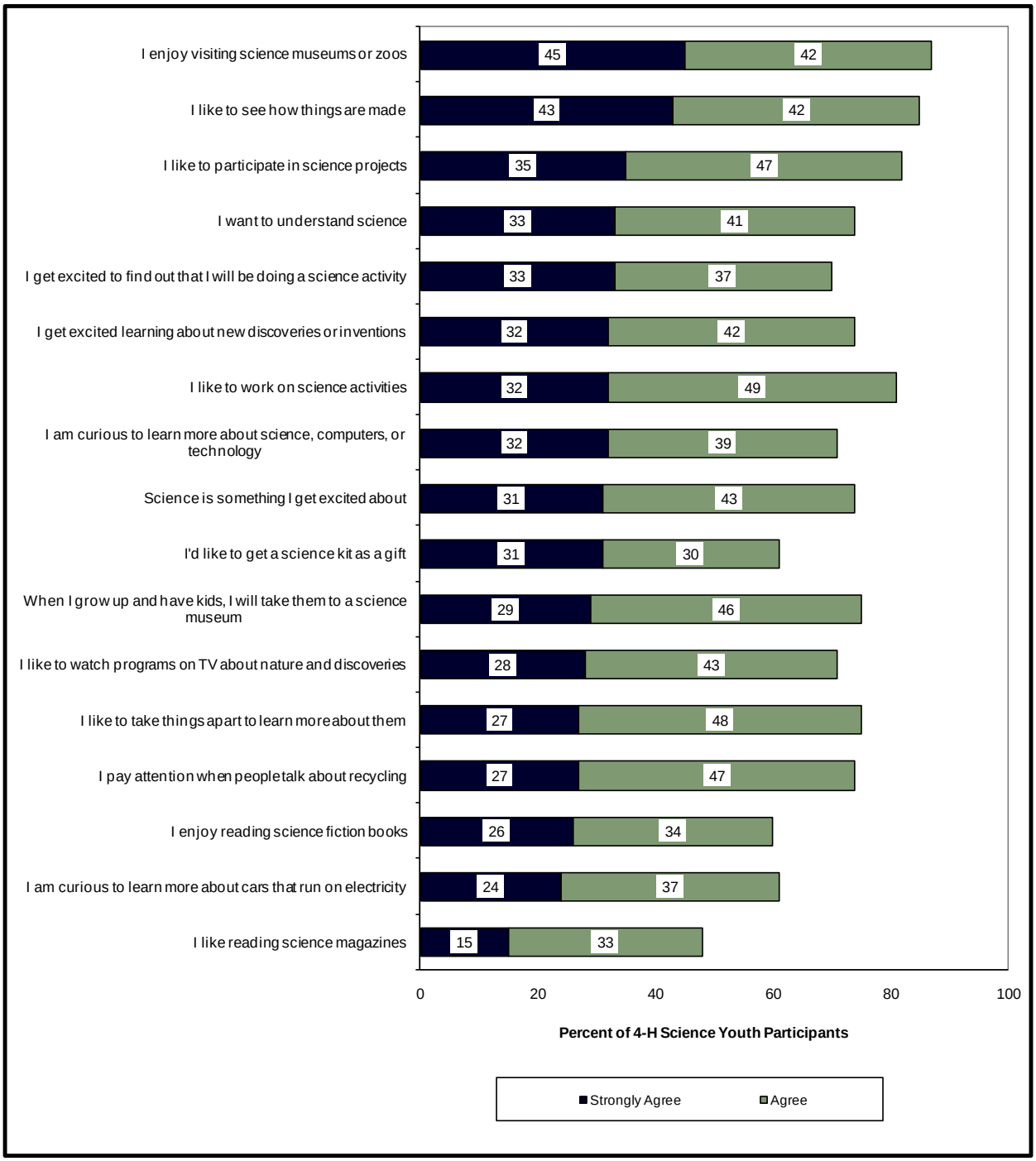

Exhibit reads: Forty-five percent of youth strongly agreed and 42 percent agreed that they enjoy visiting science museums or zoos.

Overall, young people in 4-H science programs are interested in and engaged in science activities. Their scientific interests may have been present before they joined their 4-H science program—indeed, they may have joined 4-H science programs precisely because they already had a strong interest in science. Although we cannot isolate the impact that participation in 4-H science programs may have had on youths' engagement and interest in science, these results show that programs are serving youth whose science interests could be intensified or sparked by 4-H science programming.

National Assessment of Education Progress (NAEP) science assessment comparisons. In order to compare 4-H participants' attitudes toward science against those of a representative sample of youth, we included a set of items on the survey that were taken from the NAEP Science assessments from 2005 and 2009.[11, 12] The NAEP Science assessment is administered to a nationally representative sample of fourth-, eighth-, and twelfth-grade students roughly every four years and includes a set of items designed to measure respondents' interest in science.

In this section we present the results of comparisons between 4-H participants' NAEP item responses and those of NAEP assessment youth. For youth in the fourth and eighth grades, we were able to disaggregate the NAEP data by state, allowing us to compare 4-H participants' responses only to NAEP responses in their states.[13] Comparisons of twelfth-grade youth are not conducted at the state level because the NAEP assessment does not sample twelfth-grade youth by state.

In general, youth in 4-H Science programming were more enthusiastic about science than were their peers in the NAEP sample. While the differences between the groups are apparent, the data do not tell us why 4-H youth are more enthusiastic about science, only that there is an association between enrollment in 4-H Science and youth reports of their interest in science. This association may exist because 4-H Science programs attract youth who have a pre-existing interest in science and who therefore give more enthusiastic responses to items designed to measure their engagement in science.

While most of the comparisons between 4-H Science participants and youth in the NAEP sample were statistically significant—and likely reflect real differences in the levels of interest in science between the two groups—the effect sizes were not large enough to meet this evaluation's threshold because of the large difference in the weighted NAEP sample sizes and the 4-H Science sample size. For this reason, we suggest interpreting these results with caution, and using them as anecdotal evidence of the level of interest that 4-H Science participants have in science.

Fourth-grade results. Compared to fourth-grade youth in the 2005 NAEP Science sample, fourth-grade youth enrolled in 4-H Science programs generally reported higher levels of engagement in science activities and greater enthusiasm for science. Fifty-five percent of fourth-

[11] The NAEP science assessment did not include all science attitudinal items in both the 2005 and 2009 assessments. For information on which NAEP items were asked in which administration years, please refer to Appendix D.
[12] Some of the NAEP items were also part of the Noyce Enthusiasm for Science item set; please see Appendix B for more information.
[13] Because Iowa did not participate in the 2005 NAEP, fourth-grade and eighth-grade 4-H science participants from Iowa are excluded from these analyses.

grade 4-H Science participants agreed that they are good at science, compared to 42 percent of fourth-graders in the 2005 NAEP sample (Exhibit 14). The largest difference between the two groups existed for the item that asked if youth believe science is useful for solving everyday problems. Sixty-one percent of fourth-grade 4-H Science youth agreed with the statement, compared to only 40 percent of fourth-grade youth in the NAEP sample.

Exhibit 14
Fourth-Grade 4-H Science and 2005 NAEP Respondent Attitudes Toward Science, in Percents

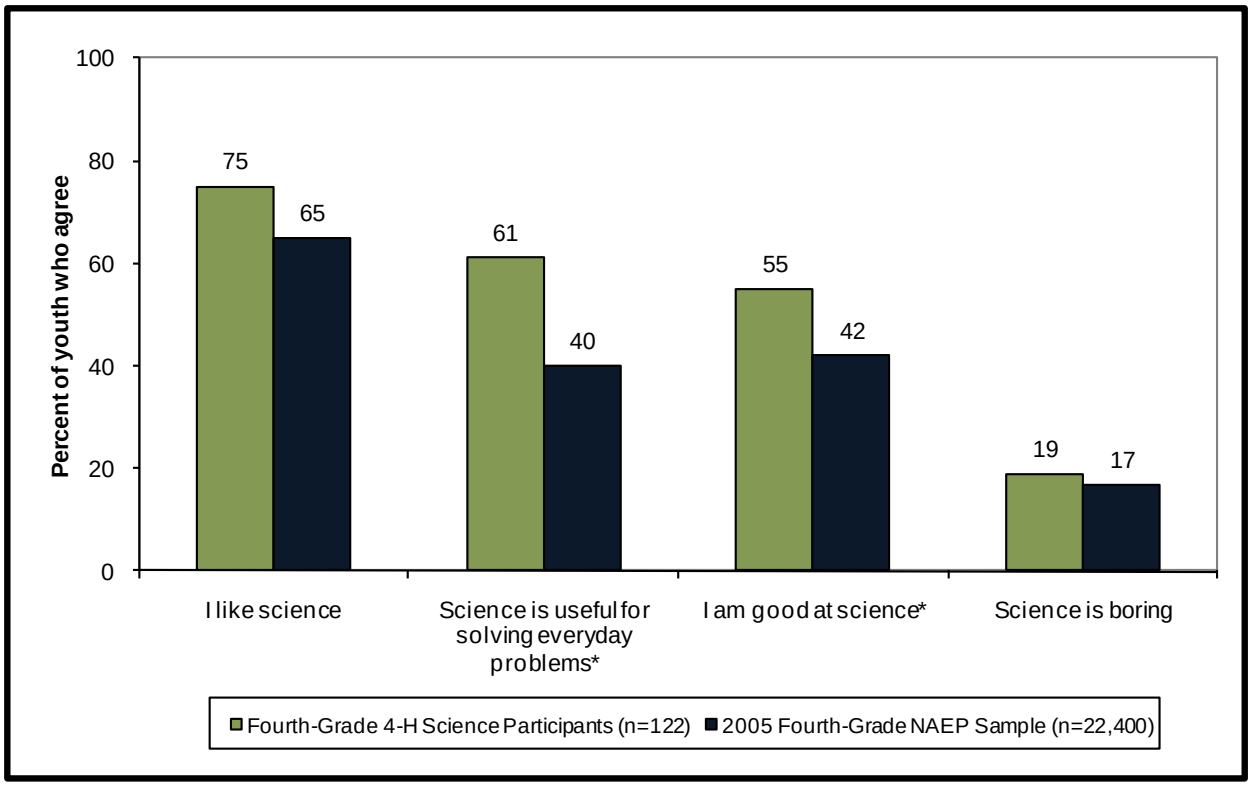

Exhibit reads: Seventy-five percent of fourth-grade 4-H Science participants agreed that they like science, compared to 65 percent of 2005 fourth-grade NAEP respondents.

*Indicates a statistically significant comparison ($p < 0.05$)

Note: 4-H respondents ages 9 and 10 were classified as fourth-graders for this analysis.

Eighth-grade results. Similar to fourth-grade participants, eighth-grade 4-H Science participants were also more enthusiastic about science than were youth in the NAEP sample of youth (Exhibit 15). For example, 61 percent of eighth-graders in 4-H Science programming agreed that they like science, compared to 51 percent in the NAEP sample of eighth-grade youth. Only 14 percent of eighth-grade youth in 4-H Science programs agreed that science is boring, as compared with 30 percent of eighth-grade youth in the NAEP sample.

Exhibit 15
Eighth-Grade 4-H Science and 2005 NAEP Respondent Attitudes Toward Science, in Percents

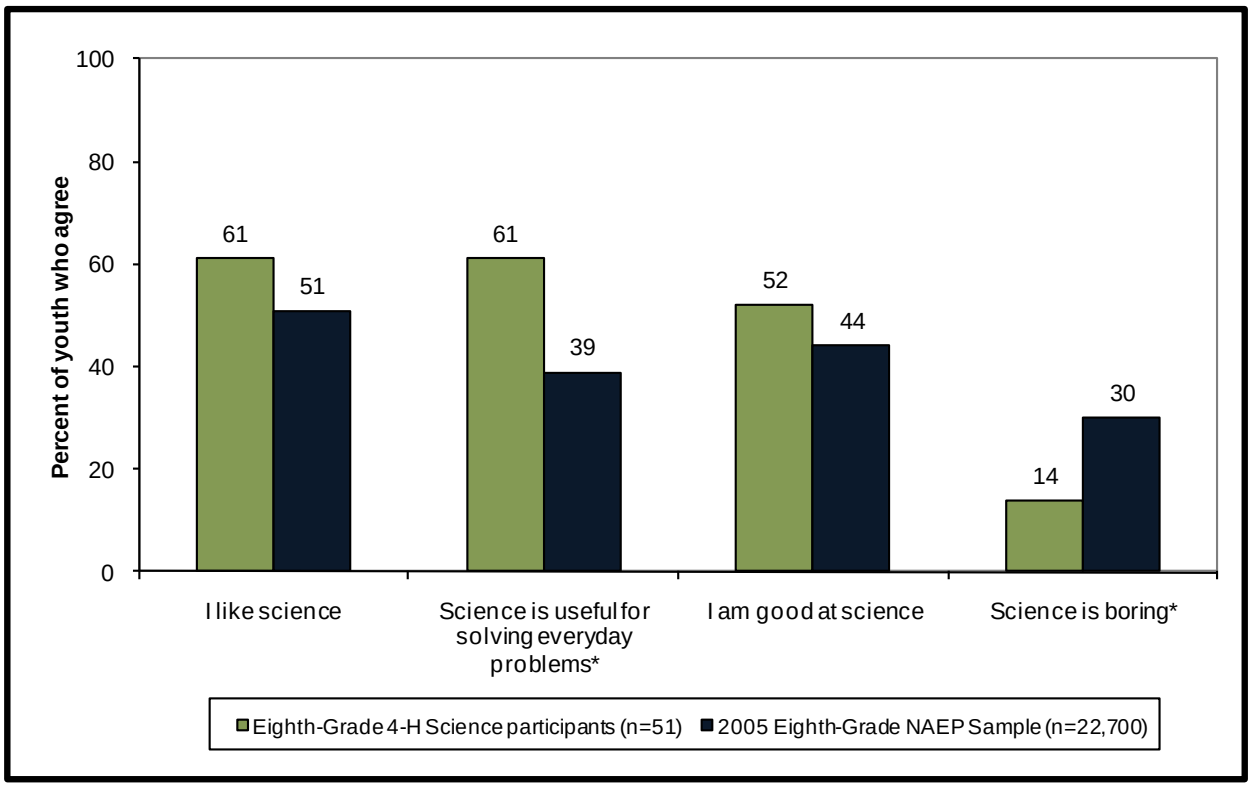

Exhibit reads: Sixty-one percent of eighth-grade 4-H Science participants agreed that they like science, compared to 51 percent of eighth-grade youth in the 2005 NAEP sample.

*Indicates a statistically significant comparison ($p < 0.05$)

Note: 4-H respondents ages 13 and 14 were classified as eighth-graders for this analysis.

A greater number of eighth-grade youth agreed that science is one of their favorite subjects than did youth in the NAEP sample (64 percent compared to 46 percent), as shown in Exhibit 16. However, roughly equal percentages of eighth graders in both the YEAK and NAEP samples reported that they take science only because it will help them in the future (60 percent compared to 56 percent). This suggests that while 4-H Science participants enjoy science more than their peers, they might not participate in science activities if they did not perceive the potential for future benefit.

Exhibit 16
Eighth-Grade 4-H Science and 2009 NAEP Respondent Attitudes Toward Science, in Percents

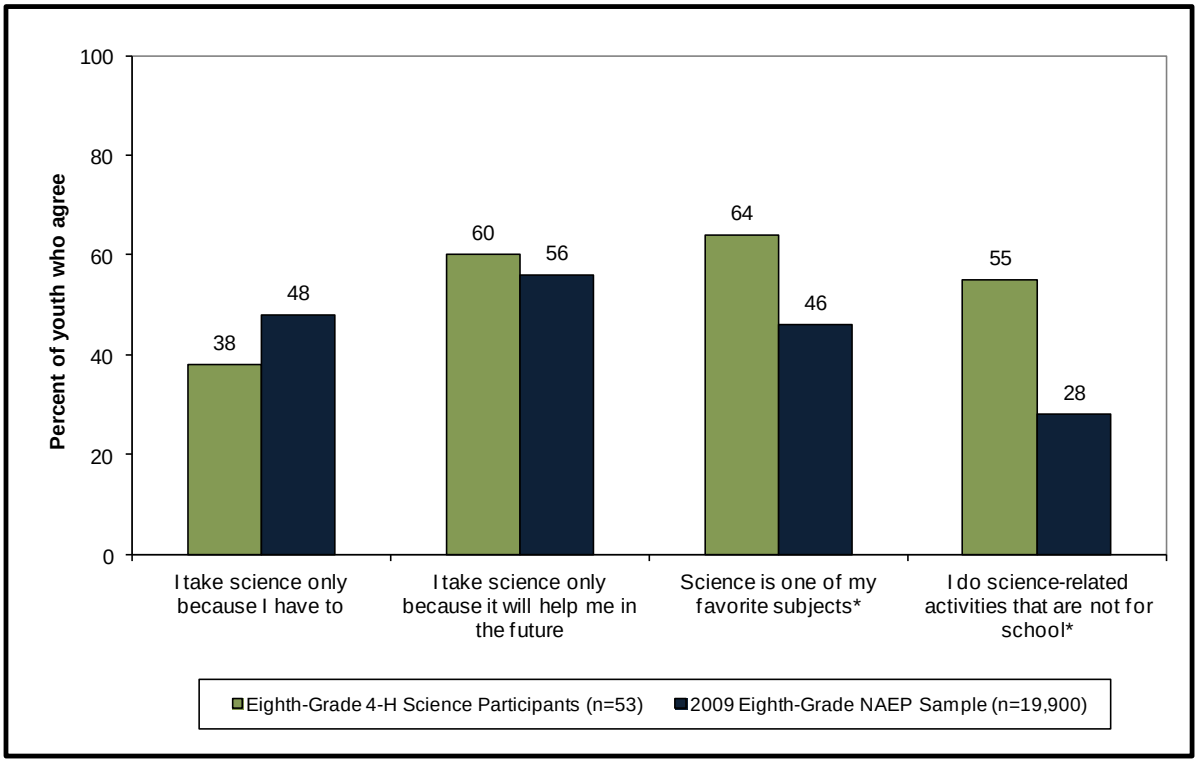

Exhibit reads: Thirty-eight percent of eighth-grade 4-H Science participants agreed that they take science only because they have to, compared to 48 percent of 2009 eighth-grade NAEP respondents.

*Indicates a statistically significant comparison ($p < 0.05$)

Note: 4-H respondents ages 13 and 14 were classified as eighth graders for this analysis.

Twelfth-grade results. Like their fourth- and eighth-grade counterparts, twelfth-grade youth participating in 4-H Science programming reported higher levels of engagement in science. These differences are more pronounced at this age group, suggesting that youth participating in 4-H Science activities at this age level have a strong, established interest in science.

As shown in Exhibit 17, 67 percent of twelfth-grade 4-H Science participants agreed that they would like to have a science-related job, compared to 37 percent of twelfth-grade youth in the national sample. Similar percentages of twelfth-graders in each group agreed that they only take science because it will help them in the future (51 percent in both groups). Again, this suggests that while 4-H youth are more engaged in science than are their peers, they might not enroll in science activities if they did not foresee future benefits. While this is not necessarily a finding that should be interpreted negatively, it is interesting to note how youth perceive the potential utility of science in their future education or career.

Exhibit 17
Twelfth-Grade 4-H Science and 2009 NAEP Respondent Attitudes Toward Science, in Percents

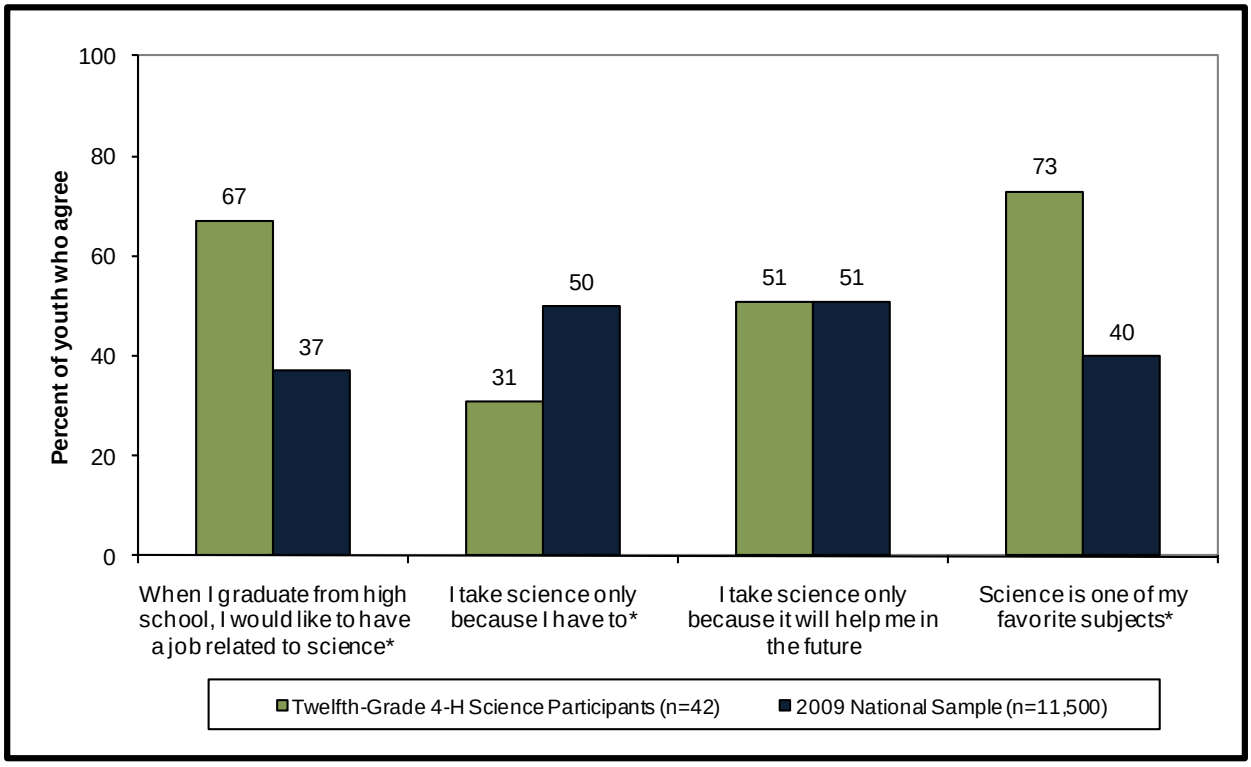

Exhibit reads: Sixty-seven percent of twelfth-grade 4-H Science participants agreed that they would like to have a science-related career after graduating from high school, compared to 37 percent of 2009 twelfth-grade NAEP respondents.

*Indicates a statistically significant comparison ($p < 0.05$)

Note: Sampling for the twelfth-grade NAEP assessment is not conducted by state, and no state-level data are available. Data depicted here reflect the 2009 national NAEP sample of twelfth-grade youth. 4-H respondents ages 17 and 18 were classified as twelfth-graders for this analysis.

Educational and Career Aspirations

The 4-H Science Initiative seeks to expose youth to career opportunities in science fields. This goal is in line with current national goals related to science: the National Research Council's Committee on Highly Successful Schools or Programs for K-12 STEM Education, in setting out goals for STEM education in the United States, highlighted the importance of preparing people for science-related careers (NRC, 2011).

4-H science programs are well-positioned to influence young people's career aspirations: research has shown that young people's interest in science careers may solidify at an early age. An analysis of longitudinal data from youth participating in the National Educational Longitudinal Study of 1988 points to the importance of students' interest in science careers as early as eighth grade in their eventual pursuit of a science major (Tai et al, 2006). Participating in a 4-H Science program at a young age could lay the groundwork for pursuing a science career later in life.

Youth in 4-H Science programming reported having high educational aspirations. When asked how far they want to go in school, half of youth surveyed (52 percent) want to finish college, while an additional 37 percent reported that they want to get more education after completing a college degree. Three percent said they would like to go to college for a little while, 2 percent said they wanted to attend a vocational school, and 7 percent said they wanted to graduate from high school. When we asked youth if they wanted to pursue a science-related career after graduating from high school, 54 percent of youth agreed or strongly agreed.

Participation in Community Science Activities

The 4-H Science logic model lists helping youth apply their science-related skills to solve everyday problems in their communities as a short-term outcome that 4-H Science programs should endeavor to achieve with youth. This goal of developing citizen-scientists reflects aspects of our recent national conversations about the importance of science education. Among researchers, educators, and policymakers, there is increasing agreement that science education in both formal and informal contexts should focus on helping young people understand how science functions in their everyday lives. Because active engagement in public issues increasingly relies on citizens' familiarity with scientific issues, there is increasing agreement that informal and formal education programs should help youth develop this knowledge (Bevan et al, 2010; and National Academies of Sciences Committee on Science Learning K-8, 2007).

As shown in Exhibit 18, the majority (70 percent) of 4-H Science participants reported participating in a science-related community service project in the past year, while a little more than half of youth (56 percent) have taught others about science. One-third of youth organized science-related events (35 percent) or used science tools to help their community (33 percent). (Items adapted from Silliman, 2010.)

Exhibit 18
Participation in Community Science Activities *(n=431)*

In the past year, I…	Percent of Respondents
Helped with a community service project related to science	70
Taught others about science	56
Organized or led science-related events	35
Used science tools to help the community	33

Exhibit reads: Seventy percent of youth in 4-H Science programs reported that they have helped with a community service project related to science in the past year.

Life Skills

The 4-H Science logic model identifies the acquisition and use of life skills as intended outcomes for participants. 4-H Science programs are expected to provide learning opportunities that support the development of life skills such as decision making, critical thinking, and problem solving. We asked youth to provide a self-report on their own skills in each of those areas, using items adapted from Perkins and Mincemoyer (2002).

Decision making. Nearly half of youth surveyed reported that they always think before making a choice, while 40 percent said that they think about all the information they have about different choices before coming to a decision. Thirty-nine percent reported that they always look for information to help them understand the problem at hand, 36 percent always think of past choices when making new decisions, and 30 percent consider the risks of a choice before making a decision (Exhibit 19).

Exhibit 19
Decision Making Skills, in Percents *(n=451)*

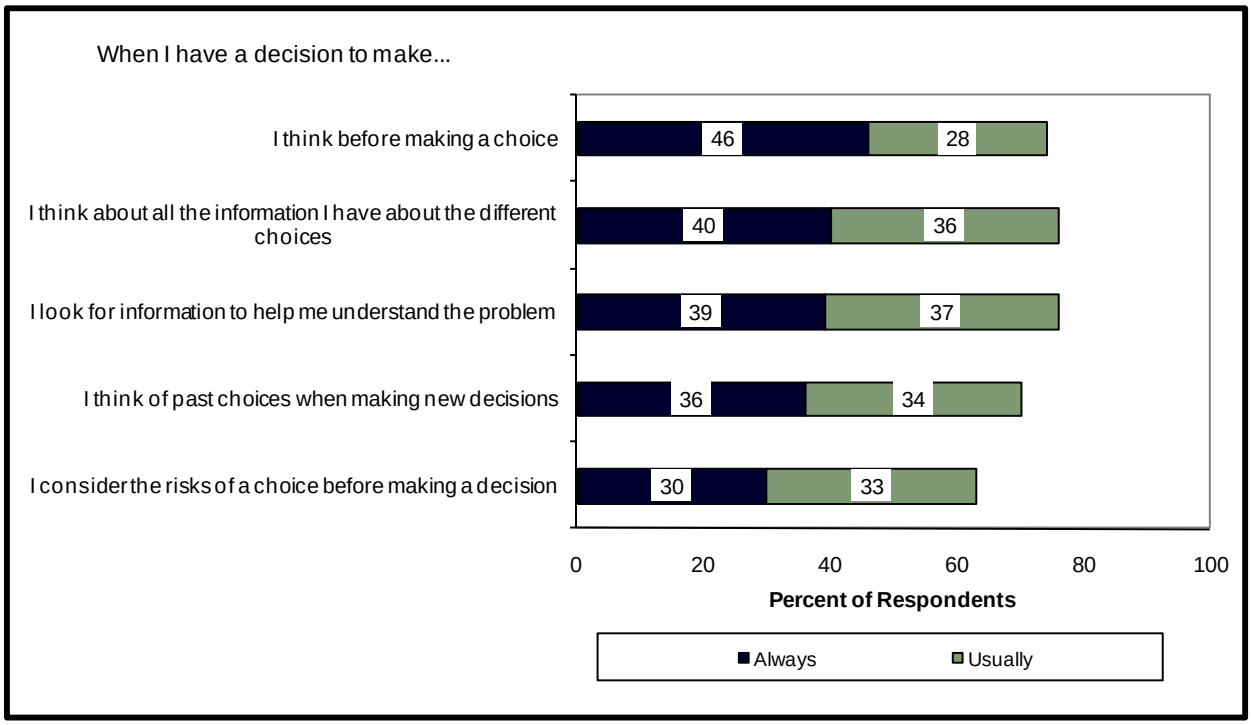

Exhibit reads: Forty-six percent of 4-H Science participants reported that they always think before making a choice; 28 percent of participants said that they usually do this.

Critical thinking. One-third (35 percent) of youth in 4-H Science programming said that they always keep their mind open to different ideas when planning to make a decision. Similar numbers of youth reported that they always: compare ideas when thinking about a topic (31 percent), easily express their thoughts on a problem (30 percent), have more than one source of information before making a decision (28 percent), and are able to tell the best way of handling a problem (27 percent), as seen in Exhibit 20.

Exhibit 20
Critical Thinking Skills *(n=447)*

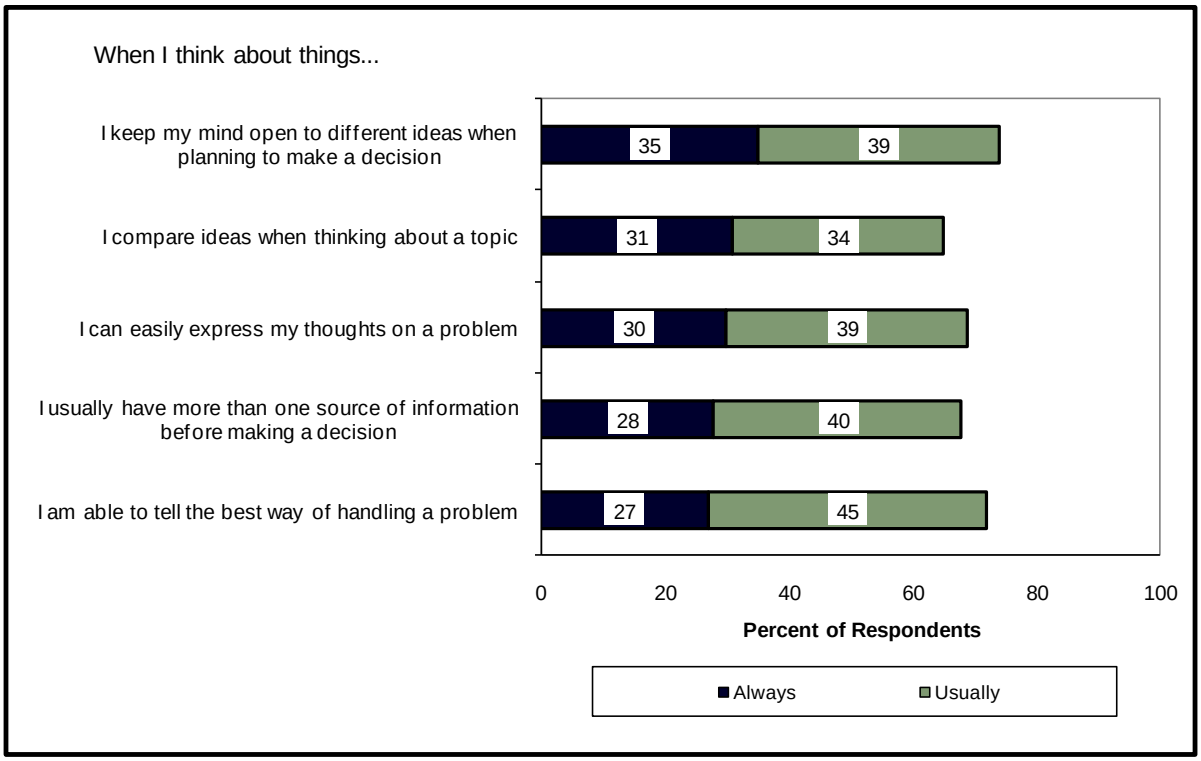

Exhibit reads: Thirty-five percent of 4-H Science participants reported that they always keep their mind open to different ideas when planning to make a decision; an additional 39 percent of participants reported that they usually do this.

Problem solving. As displayed in Exhibit 21, half of youth respondents (49 percent) said that when solving a problem, they always first figure out what the problem is. Thirty-two percent of youth reported that they always think about how their solution worked after they have solved a problem. Similar numbers of youth said that they always: try to determine what caused a problem (31 percent), compare each possible solution with others to find the best one (26 percent), think before putting a solution into action (26 percent), and do what they have done in the past to solve a problem (25 percent).

Exhibit 21
Problem Solving Skills, in Percents *(n=445)*

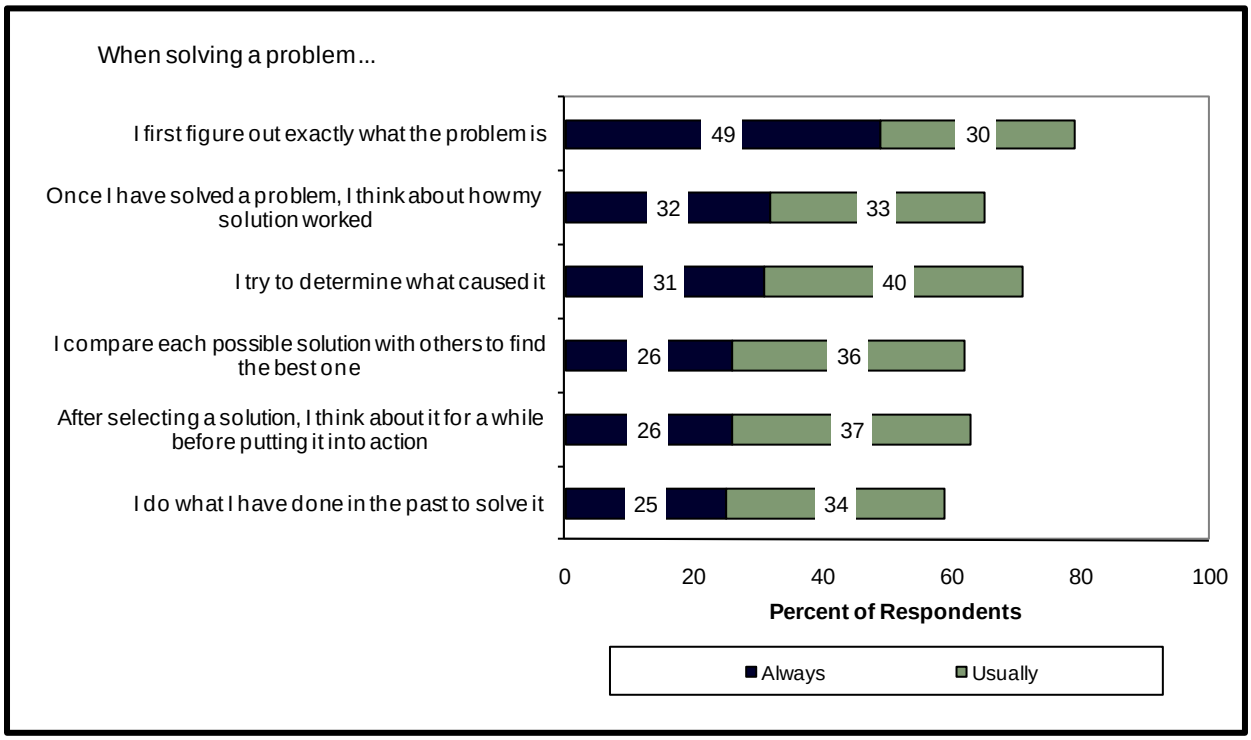

Exhibit reads: Forty-nine percent of 4-H Science participants said that when solving a problem, they always first figure out what the problem is. An additional 30 percent of participants said they usually do this.

Science Process Skills

Two of the goals of the 4-H Science logic model are for youth to use what they learn in 4-H Science programs in other contexts, and to identify new areas where they can apply their science-related skills to solve everyday problems. 4-H's goal of developing informed citizens with an understanding of how science works reflects many of our national conversations about the importance of STEM education. The possession of these science-related skills and the ability to understand scientific concepts are essential for being an informed citizen (National Research Council, 2011).

We asked youth to rate their own abilities to perform a series of science process skills using a set of items adapted from Arnold and Bordeau, 2009. The items included two separate sets of questions, one for youth ages 9-12 and one for youth ages 13-18.

The vast majority (87 percent) of youth ages 9-12 reported that they can make a chart or picture to show information, while 86 percent said that they can do an experiment to answer a question (Exhibit 22).

Exhibit 22
Science Process Skills Inventory, Ages 9-12 *(n=270)*

I can...	Percent of Respondents, Ages 9-12
Make a chart or picture to show information	87
Do an experiment to answer a question	86
Write down information correctly	83
Tell others how to do an experiment	76
Explain why things happen in an experiment	75

Exhibit reads: Eighty-seven percent of 4-H Science participants, ages 9-12, said that they can make a chart or picture to show information.

We asked youth participants ages 13 to 18 a similar set of questions about their mastery of certain science process skills. Most youth reported that they can always or usually: use the results of their investigation to answer the questions they asked (83 percent), ask a question that can be answered by collecting data (80 percent), or record data accurately (77 percent).

Exhibit 23
Science Process Skills Inventory, Ages 13-18 *(n=132)*

I can...	Percent of Respondents, Ages 13-18
Use the results of my investigation to answer the questions I asked	83
Ask a question that can be answered by collecting data	80
Record data accurately	77
Create a display to communicate my data and observations	76
Use data to create a graph for presentation to others	75
Use models to explain my results	73
Analyze the results of a scientific investigation	73
Use science terms to share my results	68
Communicate a scientific procedure to others	67
Use scientific knowledge to form a question	66
Design a scientific procedure to answer a question	64

Exhibit reads: Eighty-three percent of 4-H Science participants, ages 13-18, said that they can always or usually use the results of their investigation to answer the questions they asked.

Science Program Environment and Benefits

Informal learning programs, like those offered as a part of 4-H Science programs, have the potential to provide engaging opportunities to learn new skills in a context focused on providing positive youth development. Current research suggests that when certain best practices are implemented, informal and out-of-school time learning programs can have a positive effect on youth. These practices are associated with increased program participation,

greater interest in the program, and increased social and emotional skills, which can result in increased academic performance. An analysis of out-of-school time research identified best practices for programs, including the development of nurturing youth-adult relationships, providing diverse and engaging activities for youth, and emphasizing multiple aspects of youth development (Moore, Bronte-Tinkew, & Collins, 2010).

In order to evaluate participants' opinions of their 4-H Science program environments, we asked them to select the three things they liked best about their science program. Youth were most enthusiastic about the relationships they have at their 4-H Science programs: 65 percent of youth said that the opportunity to spend time with their friends was their favorite part of their program, while 35 percent said that the fact that adults were caring and kind was their favorite aspect.

In addition to the relationships that youth develop in their programs, youth were enthusiastic about the science learning opportunities that their programs provide: 52 percent of youth said that getting to do hands-on science activities and projects is one of their favorite things about their program.

These results demonstrate that youth are highly interested in both the social and hands-on nature of their science program, and also reflect practices that the research community believes may be critical to achieving positive outcomes with youth.

Exhibit 24
Favorite Characteristics of This Science Program *(n=412)*

	Percent of Respondents
I get to spend time with my friends	65
I get to do hands-on science activities and projects	52
The adults are caring and kind	35
I can use tools and materials here that I don't have at school or at home	32
It is a group where I feel like I belong	26
I get opportunities to demonstrate things I have learned or made in front of others	25
It is a place where I feel safe	18
I like the curriculum/project book	16
I get positive feedback from the adults and other kids	15
I get to do community service	9

Exhibit reads: Sixty-five percent of 4-H Science participants said that getting to spend time with their friends is one of the things they like most about participating in their program.

Note: Percentages do not add to 100 because participants could select up to three responses.

Associations between Youth Characteristics and Youth Survey Responses

In this section we describe the results of analyses designed to reveal any differences among 4-H Science participants' survey responses based on participant characteristics including gender, membership in a racial or ethnic group that is underrepresented in the science fields, and the extent of the respondent's participation in 4-H Science programming.

Differences by Demographic Characteristics

Because 4-H is concerned with increasing the number of women and underrepresented minorities in the science fields, we examined whether youth survey responses differed by gender or by their membership in a racial or ethnic group that is underrepresented in science fields. By examining whether respondents gave different answers to survey items based on these characteristics, 4-H can consider whether their programming is effectively reaching all of the youth they hope to serve. All comparisons presented here meet this evaluation's threshold for statistical significance and effect size.

Gender. Boys and girls in 4-H Science programming responded differently on several scale items included in the YEAK survey. Overall, boys were more positive than were girls on a scale measuring their enthusiasm about science. However, girls gave more positive evaluations of their own decision making and critical thinking skills than did boys. Girls also gave higher average ratings to their 4-H program's overall climate.[14]

Membership in a racial or ethnic group that is underrepresented in scientific fields. In an effort to examine the differences between youth from racial and ethnic groups that are well-represented in the science fields and those that are underrepresented, youth were categorized into one of two groups according to their self-reported race or ethnicity. We categorized youth who reported being white and/or Asian American as well-represented in science fields. Youth from other racial/ethnic backgrounds (Hispanic/Latino, African American, Native American, Native Hawaiian/Other Pacific Islander, and youth who specified "other") were categorized as underrepresented.[15] Using this definition, 56 percent of youth survey respondents were from groups well-represented in science fields, with the remaining 43 percent coming from underrepresented groups.

On average, youth from underrepresented racial or ethnic groups rated their decision making, critical thinking, and problem solving skills lower than did youth from well-represented groups. Underrepresented youth also reported lower levels of enthusiasm about science than did well-represented youth. In addition, under-represented youth ages 13 to 18 also rated their science process skills lower than did well-represented youth.

[14] Scale properties are detailed in Appendix C.

[15] Youth who identified as being more than one ethnicity were considered part of the underrepresented group, unless the only two ethnicities they selected were Asian-American and White.

Underrepresented youth had lower average scores on a scale measuring benefits that they experienced from participating in their 4-H program, and also gave lower ratings of their program's overall climate than did well-represented youth.

Finally, youth from racial or ethnic groups that are underrepresented in scientific fields were significantly less likely to report wanting to pursue a science-related career than did youth from well-represented groups. Twenty-two percent of youth from underrepresented groups reported wanting to pursue a science career, compared with 36 percent of youth from well-represented groups.

Exposure to 4-H Science programming. We grouped youth into high, moderate, and low exposure categories based on their responses to two survey items about their attendance and persistence in their 4-H Science program:

- In general, how many hours do you spend in this program/project each week?
- How long have you been participating in this science, engineering, or technology program/project?

4-H does not currently monitor youth attendance or persistence in a program, so we classified youth according to their self-reported participation in 4-H Science programming. We assigned respondents to one of the three exposure groups: low, moderate, or high.

Exhibit 25
Exposure Index

How long have you been participating in this program/project?	How many hours do you spend in this program/project each week?		
	One hour or less	Between 1 and 3 hours	More than 3 hours
A month or less	Low Exposure (n=56)	Low Exposure (n=9)	Low Exposure (n=57)
Two to four months	Low Exposure (n=35)	Moderate Exposure (n=23)	Moderate Exposure (n=15)
Five to seven months	Moderate Exposure (n=34)	High exposure (n=24)	High exposure (n=11)
Eight months or more	Moderate Exposure (n=41)	High exposure (n=49)	High exposure (n=85)

Exhibit reads: Youth who reported participating for one hour or less each week and who have been participating in their project for one month or less were classified as having a low exposure to 4-H Science programming.

Thirty-six percent of respondents were classified as low-exposure, 26 percent as moderate-exposure, and 39 percent as high-exposure. For purposes of significance testing, we only compared youth in the high- and low-exposure groups.

Youth in the high-exposure group gave higher ratings to their own decision making, critical thinking, and problem solving skills. They also reported experiencing greater benefits from their science program than did youth with less exposure to their science program.

These results should be interpreted with care because youth who spend more time in their 4-H Science program may be more enthusiastic about science than youth who spend less time there, and may therefore be more likely to give positive responses about their science-related abilities and about their science program. These youth may have entered their 4-H Science program with established skills and interests in science; we cannot isolate the effects of the 4-H Science programs themselves.

Summary of Findings

- 4-H Science programming represents a wide range of 4-H delivery modes and reaches youth ranging from 5 to 18 years old. Program enrollments reflect the variety of program sizes and types, with some small clubs serving only a handful of youth, and larger state- and county-wide programs reaching as many as 3,000 youth.

- Although newer programming areas such as robotics and wind power are commonly associated with the 4-H Science Initiative, in the states evaluated, large or small animal science make up the largest single content-area block of 4-H Science programs (36 percent), and environmental science programs make up 23 percent. A large majority of programs also use a curriculum developed by 4-H (77 percent) to guide their science programs.

- 4-H Science educators' stated program objectives are largely aligned with the 4-H Science Checklist: educators prioritize both science content and process skills development, as well as providing a positive youth development context for learning.

- The overwhelming majority of paid staff and volunteers who lead science programs are female (84 percent). More than three-quarters have a college or graduate degree, and just fewer than half of educators with postsecondary degrees majored in a science-related field.

- Science educators outlined several challenges to implementing their programs, including a lack of funding to purchase curricula, and difficulty in finding an appropriate space in which to hold program meetings.

- Among youth who responded to the YEAK survey, almost half said that they were in their first year of 4-H, suggesting that many youth are coming to 4-H through 4-H Science program offerings.

- Youth are highly enthusiastic about science and they seek out opportunities to engage in both formal and informal science activities. Many youth aspire to enter scientific careers and give their own science abilities and skills high marks. When compared with their peers on survey items taken from the NAEP Science assessment, 4-H youth were far more enthusiastic about science and more confident in their science-related skills.

- Youth reported that they especially enjoyed the opportunities programs gave them to interact with friends and caring adults, and to participate in hands-on activities.

- Youth who reported attending their 4-H Science program more often and for more hours each week were more likely to rate their own life skills highly, to participate in more community science activities, and to have higher overall opinions of their science programs.

- Analyses of youth survey responses revealed that boys were slightly more enthusiastic about participating in science activities than were girls. However, girls were more likely to rate their program climates highly, and to give better evaluations of their own life skills.

- Youth belonging to racial and ethnic groups historically underrepresented in the science fields were less likely than youth from well-represented groups to report an interest in pursuing a science career, and less likely to rate their own science and life skills highly. Youth from underrepresented groups, on average, rated their program's climate and the benefits they received from attending lower than did youth from well-represented groups.

Recommendations

- Because some science educators reported facing challenges related to the affordability of science curricula, 4-H should continue to facilitate the exchange of curricular resources among states and counties, perhaps by continuing to promote online networks where educators can identify affordable curricula.

- Educators also noted that finding adequate space in which to host their 4-H Science programs was a challenge. 4-H may therefore want to collect information regarding best practices and field-tested tips to help educators identify and secure space for their programs, and then share this information with the state- and county-level staff who can advise their educators.

- In order to support and develop girls and youth from racial and ethnic groups that are underrepresented in the science fields, 4-H should continue to seek out best practices for recruiting, engaging, and supporting these youth, and to share this information among state- and county-level leadership.

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Appendix A
4-H Science Checklist

4-H Science Checklist

A "Science Ready" 4-H experience is a program that is framed in Science concepts, based on Science standards and intentionally targets the development of science abilities and the outcome articulated by the 4-H Science Logic Model. Additionally, it integrates the Essential Elements and engages participants in experiential and inquiry based learning. In addition to the following criteria below, it's also recommended that science programs offer a sustained learning experience which offers youth the opportunity to be engaged in programs with relevant frequency and duration. Utilize the following checklist to self assess the program you deliver.

To meet the needs of children, youth and the nation with high-quality science, engineering and technology programs…

☑	**Are you providing science, engineering and technology programs based on National Science Education Standards -** Science education standards are criteria to judge quality: the quality of what young people know and are able to do; the quality of the science programs that provide the opportunity for children and youth to learn science; the quality of science teaching; the quality of the system that supports science leaders and programs; and the quality of assessment practices and policies. **http://www.nap.edu/readingroom/books/nses/**
☑	**Are you providing children and youth opportunities to improve their Science Abilities?** Predict, Hypothesize, Evaluate, State a Problem, Research Problem, Test, Problem Solve Design Solutions, Measure, Collect Data, Draw/Design, Build/Construct, Use Tools, Observe, Communicate, Organize, Infer, Question, Plan Investigation, Summarize/Relate, Invent/Implement Solutions, Interpret/Analyze/Reason, Categorize/Order/Classify, Model/Graph/Use Numbers, Troubleshoot, Redesign, Optimize, Collaborate, Compare
☑	**Are you providing opportunities for youth to experience and improve in the Essential Elements of Positive Youth Development?** Do youth get a chance at **mastery** – addressing and overcoming life challenges in your programs? Do youth cultivate **independence** and have an opportunity to see oneself as an active participant in the future? Do youth develop a sense of **belonging** within a positive group? Do youth learn to share a spirit of **generosity** toward others?

☑	**Are learning experiences led by trained, caring adult staff and volunteers acting as mentors, coaches, facilitators and co-learners who operate from a perspective that youth are partners and resources in their own development?**
☑	**Are activities led with an experiential approach to learning?**
☑	**Are activities using inquiry to foster the natural creativity and curiosity of youth?**
☑	**Does your program target one or more of the outcomes on the 4-H Science Logic Model and have you considered the frequency and duration necessary for youth to accomplish those outcomes?**

Appendix B
Youth and Program Educator Survey Instruments

NATIONAL 4-H SCIENCE EVALUATION
Survey of 4-H Science Leaders

Dear 4-H Science Program Leaders and Facilitators:

Thank you for taking the time to complete this survey. As part of a three-year evaluation of 4-H Science programming, we are surveying leaders of 4-H Science clubs and programs. This survey is designed to capture information about your program and your responses will help 4-H understand how 4-H Science programs are being implemented, nationwide. Your responses are confidential; no individuals or programs will be identified in evaluation reports.

If you have any questions, please contact Joy Sanzone at www.policystudies.com.

Thank you for your help!

Program Structure

1. Do you lead a 4-H Science program? For example, a program that focuses on science, engineering, technology, or applied math?

	Select one
Yes	☐
No ***[Respondent will exit the survey]***	☐

2. Please provide the name of the 4-H Science program that you lead in the space below.

_____

3. Will this program be running in March, April, or May of this year?

	Select all that apply
March	☐
April	☐
May	☐
June	☐
None of the above	☐

4. When does this program typically take place?

	Select all that apply
During the school day	☐
After school	☐
On the weekend	☐
Over the summer	☐
Other (Please specify: _____)	☐

5. **Please indicate how often youth in the program meet as a group with you or other staff/volunteers? .**

	Enter a number
On how many days *per month* does the program meet?	_____
For approximately how many hours *per month* does the program meet?	_____

6. **We'd like to know how long this program's *current programming cycle* will be running. Please indicate the first day that this program met and the last scheduled meeting date.**

	Enter a date
Program period start-date	_____
Program period end-date	_____
Not applicable, program runs continuously or year-round	☐
Use this space to briefly describe why you are unable to provide a start- and/or end-date:	

7. **We would like to get a sense of how many youth are enrolled in this program and how frequently they attend.**

	Enter a number
Please indicate how many youth are enrolled in the program	_____
On average, how many youth attend *each program meeting*?	_____

8. **What ages (*in years*) are program participants?**

	Select all that apply
5	
6	
7	☐
8	☐
9	☐
10	☐
11	☐
12	☐
13	☐
14	☐
15	☐
16	☐
17	☐
18	☐
Other (Please specify: ____)	☐

9. How do most youth learn about and enroll in this program?

	Select all that apply
Flyers distributed around the community	☐
Word-of-mouth	☐
4-H website	☐
Through other 4-H activities	☐
School	☐
Other (Please specify:_____)	☐

Program Content

10. What are the main content areas that this program addresses? (Select up to two content areas.)

	Select one
Animal Science-Large Animal	☐
Animal Science - Small/Companion Animal	☐
Veterinary Science	☐
Food Science	☐
Consumer and Family Sciences	☐
Environmental Science	☐
Environmental Stewardship	☐
Earth Science	☐
Weather and Climate	☐
Physical Sciences	☐
Plant Science	☐
Gardening	☐
Horticulture	☐
Technology	☐
Engineering	☐
Aerospace/Rocketry	☐
Computer Technology	☐
Geospatial Technology (GIS/GPS)	☐
Robotics	☐
Other, please specify _____	☐

11. Does this program use any of the following 4-H Science curricula to guide activities?

	Select one
Animal science curricula (poultry, beef, etc.)	☐
The Power of Wind	☐
There's No New Water	☐
Robotics	☐
Exploring Your Environment	☐
Acres of Adventure	☐
No, we do not use a 4-H Science curriculum	☐
Other (Please specify:_____)	☐

12. Does this program use a published curriculum created by an organization *other than 4-H* in order to guide activities?

	Select one
No	☐
Yes (Please specify: _____)	☐

13. Do you create, or do you require other staff or volunteers to create, lesson plans for each program meeting?

	Select one
No, we do not use lesson plans	☐
We use lesson plans once in a while, but not regularly	☐
We usually use lesson plans, but not always	☐
Yes, there are lesson plans for each program meeting	☐
Other (Please specify:_____)	☐

14. To what extent is each of the following an objective of your 4-H Science program?

Program objectives	***Select one***		
	Major Objective	**Minor Objective**	**Not an Objective**
Help youth develop pro-social and interpersonal skills	☐	☐	☐
Provide hands-on, experiential learning activities	☐	☐	☐
Use national science education standards to inform and guide activities	☐	☐	☐
Teach youth about a specific science content area (e.g., computer programming, animal behavior, plant science, etc.)	☐	☐	☐
Help youth practice science-related skills (e.g., pose questions or hypotheses, collect data, (de)construct an object, analyze information, present findings or results, etc.)	☐	☐	☐
Help youth become aware of the roles science plays in their everyday lives	☐	☐	☐
Encourage youth to develop an interest in science	☐	☐	☐
Help youth understand how science can help them to improve their communities	☐	☐	☐
Other (Please specify)	☐	☐	☐
Use this space to briefly describe "Other" objectives:			

15. Of the items you identified as major objectives, how easy or difficult is each one to achieve.

Program objectives	***Select one***			
	Very Easy	**Easy**	**Difficult**	**Very Difficult**
Help youth develop pro-social and interpersonal skills	☐	☐	☐	☐
Provide hands-on, experiential learning activities	☐	☐	☐	☐
Use national science education standards to inform and guide activities	☐	☐	☐	☐
Teach youth about a specific science content area (e.g., computer programming, animal behavior, plant science, etc.)	☐	☐	☐	☐
Help youth practice science-related skills (e.g., pose questions or hypotheses, collect data, (de)construct an object, analyze information, present findings or results, etc.)	☐	☐	☐	☐
Help youth become aware of the roles science plays in their everyday lives	☐	☐	☐	☐
Encourage youth to develop an interest in science	☐	☐	☐	☐
Help youth understand how science can help them to improve their communities	☐	☐	☐	☐
Other (Please specify)	☐	☐	☐	☐

Please discuss why each of these items is easy or difficult.

_____

_____

16. To what extent is each of the following a challenge to implementing your 4-H Science program?

Challenges	***Select one***		
	Major Challenge	**Minor Challenge**	**Not a Challenge**
Low enrollment	☐	☐	☐
Irregular youth attendance	☐	☐	☐
Limited access to appropriate physical space	☐	☐	☐
Limited access to necessary supplies (e.g., GPS devices, computers, etc.)	☐	☐	☐
Lack of volunteers with science skills or knowledge	☐	☐	☐
Lack of funding to purchase science-related curricula	☐	☐	☐
Lack of science-related training opportunities for volunteers/staff	☐	☐	☐
Other (Please specify)	☐	☐	☐

Use this space to briefly describe "Other" challenges:

_____

_____

_____

_____

17. Please indicate how often, if ever, youth engage in the following activities as part of this program.

Activities	*Select one*			
	At Every Meeting	**At Nearly Every Meeting**	**Once in a While**	**Never**
Take field trips to see how science is used in real life	☐	☐	☐	☐
Meet with adults who work in science-related fields	☐	☐	☐	☐
Learn about careers that use science	☐	☐	☐	☐
Learn about the educational choices that youth must make to pursue a science-related career	☐	☐	☐	☐
Work together on teams or in groups	☐	☐	☐	☐
Build or construct things	☐	☐	☐	☐
Develop questions and then research or look for answers	☐	☐	☐	☐
Design a test to explore an idea or hypothesis	☐	☐	☐	☐
Gather data or information	☐	☐	☐	☐
Use tools or technology (e.g., GIS/GPS, computer, scale)	☐	☐	☐	☐
Conduct experiments	☐	☐	☐	☐
Analyze or interpret information or data	☐	☐	☐	☐
Present data or information to a group	☐	☐	☐	☐
Design a test to explore an idea or hypothesis	☐	☐	☐	☐
Use computer software to design or build something (e.g., website, programming for a robot)	☐	☐	☐	☐
Use the internet for research	☐	☐	☐	☐
Other (Please specify)	☐	☐	☐	☐
Use this space to briefly describe "Other" activities: _____ _____ _____ _____ _____				

Program Supports

18. On average, how often do you discuss issues related to providing science programming with 4-H representatives from your county or state?

	Select one
About once a week	☐
A few times a month	☐
Several times a year	☐
Once a year	☐
Never	☐

19. How much do you agree or disagree with the following statements?

	Select one			
	Strongly Agree	**Agree Somewhat**	**Disagree Somewhat**	**Strongly Disagree**
The training and support I have received in positive youth development has been adequate	☐	☐	☐	☐
The training and support I have received in science content has been adequate	☐	☐	☐	☐
The training and support I have received in science instructional methods has been adequate	☐	☐	☐	☐
I receive adequate support from my county 4-H office	☐	☐	☐	☐
I receive adequate support from my state 4-H office	☐	☐	☐	☐

20. What type of financial and in-kind supports currently help keep this program running?

	Select all that apply
Fees or dues from participants	☐
In-kind or financial contributions from a business or organization outside of 4-H	☐
Local 4-Hoffice	☐
State 4-H office	☐
I contribute money or donate supplies	☐
Other (Please specify: _____)	☐

Program Volunteers/Staff

21. *In addition to you*, do any other volunteers or staff members help lead this program on a *regular basis*?

	Select one
Yes	☐
No *(skip to question 23)*	☐

22. How many staff and/or volunteers in your 4-H Science program fit in each of the categories below? *(Write a number on each line. If no staff fit into a category, write "0." If staff/volunteers fit in multiple categories, pick the one that you believe best describes them.)*

	Enter a number
Parents of participants	_____
Other adults with science-related expertise	_____
Other adults without science-related expertise	_____
College students who are *science majors*	_____
College students who are *education majors*	_____
Other college students	_____
High school students	_____

Noyce Staff Items

23. Are you:

	Select one
20 years old or younger	☐
21 years old or older	☐

24. Are you:

	Select one
Male	☐
Female	☐

25. What is your highest level of education?

	Select one
Middle school *(skip to question 27)*	☐
High school diploma or GED *(skip to question 27)*	☐
Some college coursework	☐
2-year college completion	☐
Undergraduate degree	☐
Graduate degree	☐

26. If you attended college, did you major in science, technology, engineering or mathematics?

	Select one
Yes	☐
No	☐

27. Are you currently in school?

	Select one
No	☐
Yes, in high school	☐
Yes, in college or university	☐
Yes, other _____	☐

28. For how long have you worked or volunteered in a youth development program? _____ years

29. Before leading this program, did you previously work or volunteer in a youth program with a science, technology, engineering, or mathematics focus?

	Select one
Yes	☐
No	☐

30. In what industry do you work?

	Select one
Farming or ranching	☐
Military, police, or security	☐
Banking, finance, or accounting	☐
Computers and technology	☐
Research	☐
Medicine (doctor, nurse, lab technician)	☐
Teacher/Education, please specify _____	☐
Arts (writing, dancing, painting)	☐
Skilled trades (carpenter, plumber)	☐
Retail	☐
Engineering or architecture	☐
Law	☐
Other, please specify _____	☐

[If respondent indicated that their program will be in session in March, April, May, or June at the beginning of the survey, ask them to complete this contact info question.]

A random sample of 4-H Science programs will be selected to administer Youth Engagement, Attitude, and Knowledge (YEAK) surveys to youth participants this spring. Please provide a mailing address and phone number that we can use to send YEAK surveys to you this spring in the spaces below. If your program is selected as part of the random sample, we will contact you and let you know.

Name: _____
Address: _____
City:_____
State: _____
Zip:_____
Phone number: _____
Email address: _____

THANK YOU!

4-H Science Youth Survey

Dear Participant:

You are being given this survey **because you are part of a 4-H program or project that has to do with science,** and we are surveying young people like you to learn about your experiences.

This survey is voluntary. If you do not want to fill out the survey, you do not need to. However, we hope you will take a few minutes to fill it out because your answers are important.

This survey is private. No one at your school, home, or 4-H program or project will see your answers. Please answer all of the questions as honestly as you can. If you are uncomfortable answering a question, you may leave it blank.

This is not a test. There are no right or wrong answers, and your answers will not affect your participation or place in the program in any way.

Thank you for your help!

1. How many years have you been participating in 4-H? (Select ONE.)
   a. This is my first year 1
   b. This is my second year 2
   c. Three or more years 3

2. How long have you been participating in **this** science program/project? (Select ONE.)
   a. A month or less 1
   b. Two to four months 2
   c. Five to seven months 3
   d. Eight months or more 4

3. Have you ever been in another **4-H program or project about science**? (Select ONE.)
   a. Yes 1
   b. No 2
   c. Don't know 3

4. In general, how many hours do you spend in this program/project each week? (Select ONE.)
   a. One hour or less each week 1
   b. Between one and three hours each week 2
   c. More than three hours each week 3

5. What types of 4-H programs or projects are you involved in? (Select ALL that apply.)
   a. Clubs 1
   b. Camps 1
   c. After-school programs 1
   d. Local fairs/events 1
   e. Community service projects 1
   f. Working on my projects at home 1
   g. Other 1

6. I joined 4-H because… (Select ALL that apply.)
   a. Of the types of activities that you get to do 1
   b. My friends were in it 1
   c. My parents signed me up for it 1
   d. Other 1

7. Please tell us how much you agree or disagree that this 4-H program or project gives you the opportunity to do each of the following things. (Select ONE in each row.)

In this 4-H program or project, I can …	***Strongly Disagree***	***Disagree***	***Agree***	***Strongly Agree***
a. Do experiments	1	2	3	4
b. Do hands-on science activities	1	2	3	4
c. Solve problems	1	2	3	4
d. See science in a fun way	1	2	3	4
e. Learn about careers	1	2	3	4
f. Serve my community	1	2	3	4
g. Learn with my friends	1	2	3	4
h. Get answers to my questions from leaders	1	2	3	4
i. Tell a group of people about something I learned or made	1	2	3	4

8. Pick the <u>three things</u> that you like best about coming to this 4-H program or project: (Select only THREE.)

   a. The adults are caring and kind (staff, leaders, volunteers) 1
   b. I like the curriculum/project book 1
   c. It is a place where I feel safe 1
   d. It is a group where I feel like I belong 1
   e. I can use tools and materials here that I don't have at school or at home 1
   f. I get to spend time with my friends 1
   g. I get to do hands-on activities and projects 1
   h. I get positive feedback from the adults and other kids 1
   i. I get to do community service 1
   j. I get opportunities to demonstrate things I have learned or made in front of others 1

9. Please tell us how often you think the following things are true when you are at this 4-H program or project. (Select ONE in each row.)

In this 4-H program or project …	***Never***	***Sometimes***	***Usually***	***Always***
a. I feel safe and respected	1	2	3	4
b. I am afraid I will be embarrassed or put down	1	2	3	4
c. All kinds of kids are welcome	1	2	3	4
d. Adults listen to what I have to say	1	2	3	4
e. I feel comfortable going to adults for advice	1	2	3	4
f. Other kids care about me	1	2	3	4
g. I feel like I can make a difference	1	2	3	4
h. I am encouraged to take responsibility	1	2	3	4
i. It is OK to make mistakes	1	2	3	4

10. We are interested in how often you do the following things. (Select ONE in each row.)

When I have a decision to make...	***Never***	***Sometimes***	***Usually***	***Always***
a. I look for information to help me understand the problem	1	2	3	4
b. I think before making a choice	1	2	3	4
c. I consider the risks of a choice before making a decision	1	2	3	4
d. I think about all the information I have about the different choices	1	2	3	4
e. I think of past choices when making new decisions	1	2	3	4

When I think about things...	***Never***	***Sometimes***	***Usually***	***Always***
a. I can easily express my thoughts on a problem	1	2	3	4
b. I usually have more than one source of information before making a decision	1	2	3	4
c. I compare ideas when thinking about a topic	1	2	3	4
d. I keep my mind open to different ideas when planning to make a decision	1	2	3	4
e. I am able to tell the best way of handing a problem	1	2	3	4

When solving a problem....	*Never*	*Sometimes*	*Usually*	*Always*
a. I first figure out exactly what the problem is	1	2	3	4
b. I try to determine what caused it	1	2	3	4
c. I do what I have done in the past to solve it	1	2	3	4
d. I compare each possible solution with others to find the best one	1	2	3	4
e. After selecting a solution, I think about it for a while before putting it into action	1	2	3	4
f. Once I have solved a problem, I think about how my solution worked	1	2	3	4

11. Please indicate the extent to which you agree or disagree with each of the following statements. (Select ONE in each row.) (***Noyce Enthusiasm for Science Items)***

	Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
a. Science is something I get excited about	1	2	3	4
b. I like to take things apart to learn more about them	1	2	3	4
c. I like to participate in science projects	1	2	3	4
d. I'd like to get a science kit as a gift (for example, a microscope, magnifying glass, a robot, etc.)	1	2	3	4
e. I like to see how things are made (for example, ice-cream, a TV, an iPhone, energy, etc)	1	2	3	4
f. I like to watch programs on TV about nature and discoveries	1	2	3	4
g. I am curious to learn more about science, computers or technology	1	2	3	4
h. I like to work on science activities	1	2	3	4
i. When I grow up and have kids, I will take them to a science museum	1	2	3	4

j. I want to understand science (for example, to know how computers work, how rain forms, or how airplanes fly)	1	2	3	4
k. I enjoy visiting science museums or zoos	1	2	3	4
l. I get excited learning about new discoveries or inventions	1	2	3	4
m. I like reading science magazines	1	2	3	4
n. I pay attention when people talk about recycling to protect our environment	1	2	3	4
o. I am curious to learn more about cars that run on electricity	1	2	3	4
p. I get excited to find out that I will be doing a science activity	1	2	3	4
q. I enjoy reading science fiction books	1	2	3	4

12. Please indicate the degree to which you agree or disagree with the following statements. (Select ONE in each row.)

	Disagree	***Not Sure***	***Agree***
a. I like science ***(Noyce item)***	1	2	3
b. I am good at science	1	2	3
c. Science is boring ***(Noyce item)***	1	2	3
d. Science is useful for solving everyday problems	1	2	3

13. Please indicate the extent to which you agree or disagree with the following statements. (Select ONE in each row.)

	Strongly Disagree	***Disagree***	***Agree***	***Strongly Agree***
a. When I graduate from high school, I would like to have a job related to science	1	2	3	4
b. Science is one of my favorite subjects	1	2	3	4
c. I do science-related activities that are not for schoolwork	1	2	3	4
d. I take science only because I have to	1	2	3	4
e. I take science only because it will help me in the future	1	2	3	4

14. In the past year, have you done any of the following things? (Select YES or NO.)

	Yes	*No*
a. Helped with a community service project that relates to science (for example: planted trees or gardens, road or stream clean-up, recycling)	1	2
b. Used science tools to help the community (for example: mapped with GIS, tested water quality)	1	2
c. Taught others about science (for example: demonstrated, gave presentation at community meeting or at school)	1	2
d. Organized or led science-related events (for example: science fair, environmental fair)	1	2

15. How old are you? _____

16. Are you... (Select ONE.)
    a. A boy 1
    b. A girl 2

17. Are you... (Select ALL that apply.)
    a. African American/Black 1
    b. Asian 1
    c. Hispanic/Latino 1
    d. Native American/Alaskan Native 1
    e. Native Hawaiian/Other Pacific Islander 1
    f. White 1
    g. Other 1

18. What type of school do you go to? (Select ONE.)
    a. Public school 1
    b. Private school 2
    c. Religious school (Catholic, etc.) 3
    d. Home school 4

19. How far do you want to go in school? (Select ONE.)
    a. Graduate from high school 1
    b. Go to a trade or vocational school 2
    c. Go to college for a little while 3
    d. Finish college 4
    e. Get more education after college 5

20. What kind of work do you expect to be doing when you are 30 years old? (Select ONE.)

a. Farmer, rancher 1
b. Military, police, or security officer 2
c. Professional business person or manager 3
d. Own a business 4
e. Work in computers or technology 5
f. Scientist or researcher 6
g. Work in the medical field (doctor, nurse, lab technician) 7
h. Teacher 8
i. Artist (writer, dancer, painter) 9
j. Skilled craftsperson (carpenter, plumber) 10
k. Retail (work in a store) 11
l. Engineer or architect 12
m. Lawyer 13
n. Other 14
o. Don't know 15

If you are 12 years old or younger, please answer this question. If you are 13 or older, please skip this question and go on to the next question.

21a. Please let us know whether each of these statements is true for you. (Select YES or NO.)

	Yes	***No***
a. I can do an experiment to answer a question	1	2
b. I can tell others how to do an experiment	1	2
c. I can write down information correctly	1	2
d. I can make a chart or picture to show information	1	2
e. I can explain why things happen in an experiment	1	2

If you are 12 or younger, you have finished the survey. Thank you!

If you are 13 or older, please answer this question.

21b. Please let us know how often each of these statements is true for you. (Select ONE in each row.)

	Never	***Sometimes***	***Usually***	***Always***
a. I can use scientific knowledge to form a question	1	2	3	4
b. I can ask a question that can be answered by collecting data	1	2	3	4
c. I can design a scientific procedure to answer a question	1	2	3	4
d. I can communicate a scientific procedure to others	1	2	3	4
e. I can record data accurately	1	2	3	4
f. I can use data to create a graph for presentation to others	1	2	3	4
g. I can create a display to communicate my data and observations	1	2	3	4
h. I can analyze the results of a scientific investigation	1	2	3	4
i. I can use science terms to share my results	1	2	3	4
j. I can use models to explain my results	1	2	3	4
k. I can use the results of my investigation to answer the questions I asked	1	2	3	4

Thank you!

Appendix C
Statistical Properties of Survey Scales

For each series of survey items addressing a common theme, evaluators created a survey scale to measure Science participants' overall response to that theme. This appendix describes the individual items that are included in each scale, and presents the following statistical properties of each scale:

- **Cronbach's Alpha:** a measure of the internal consistency of the survey scale ranging from 0-1, with higher numbers indicating a greater cohesiveness of items
- **Mean:** the average score on the scale across all participants, ranging from 1 to 4
- **Standard deviation:** an estimate of the average variability of the scale data
- **Minimum/maximum:** the minimum and maximum scores possible on the scale
- **25th percentile/75th percentile:** respectively, the scale scores below which 25 percent of participants and 75 percent of participants scored

Critical Thinking Scale

The critical thinking scale was computed to range from one to four, with four indicating that on average, participants said they always do the following:

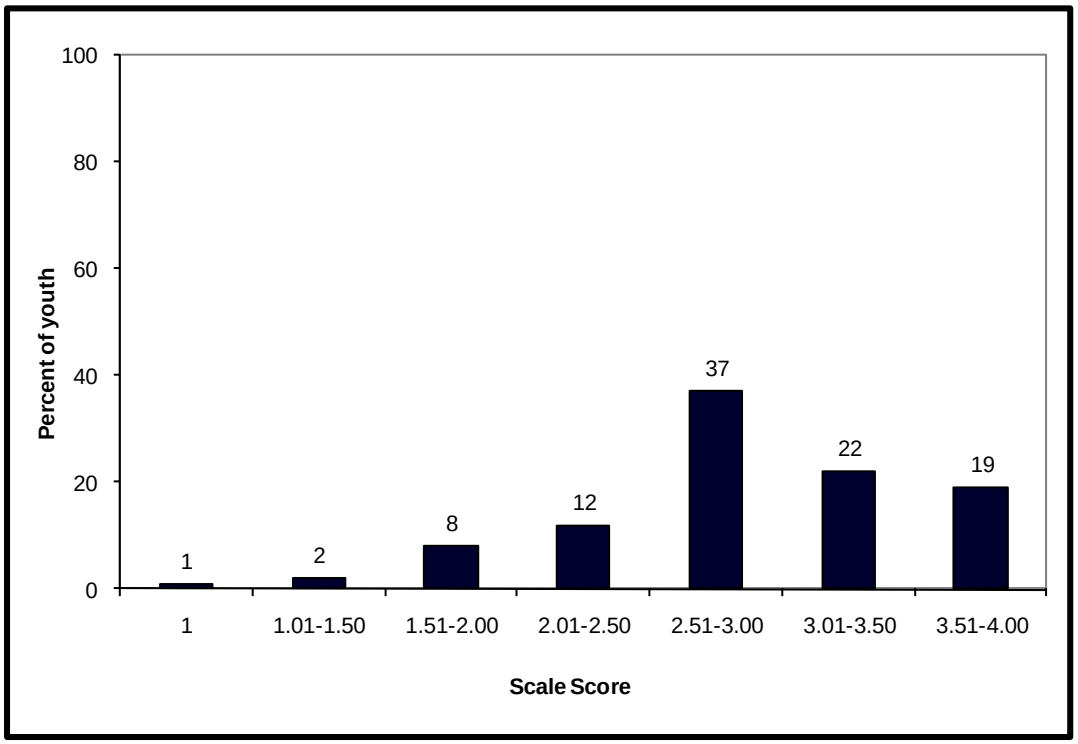
When I think about things I…

- Can easily express my thoughts on a problem
- Usually have more than one source of information before making a decision
- Compare ideas when thinking about a topic
- Keep my mind open to different ideas when planning to make a decision
- Am able to tell the best way of handling a problem

Items adapted from: Perkins & Mincemoyer, 2002.

Statistical Properties:

Alpha	Mean	Standard Deviation	Minimum	25th Percentile	75th Percentile	Maximum
0.76	2.94	0.63	1	2.60	3.40	4



Decision Making

The Decision Making Scale was computed to range from one to four, with four indicating that on average participants said they always do the following:

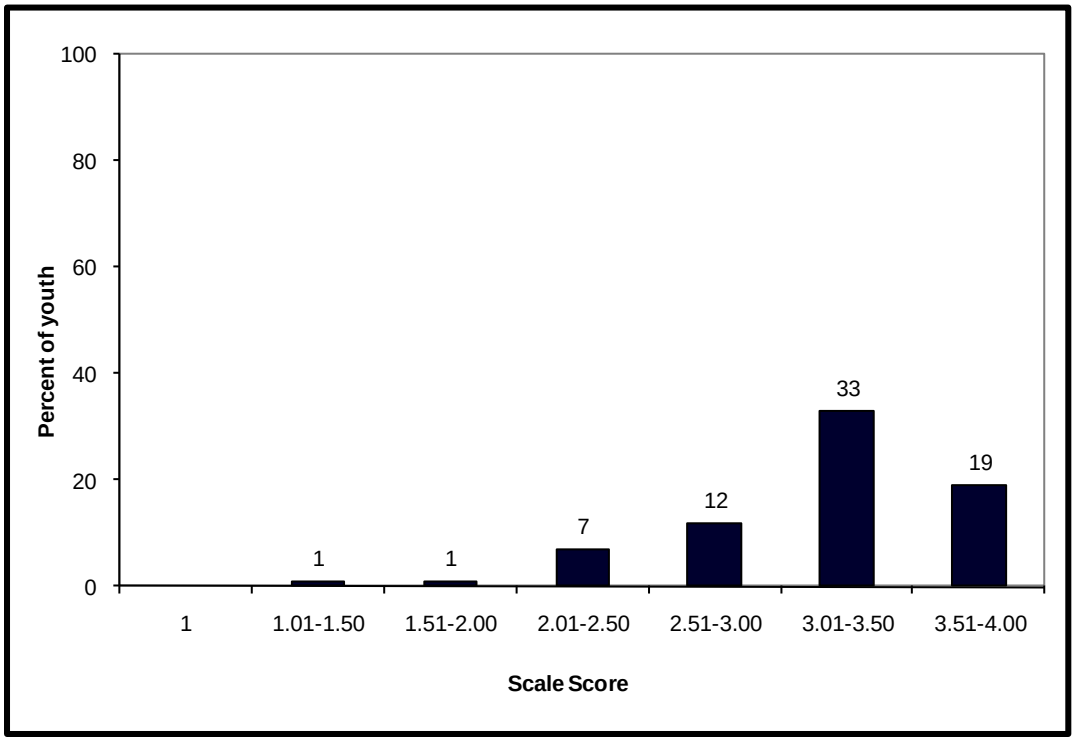
When I have a decision to make I…

- Look for information to help me understand the problem
- Think before making a choice
- Consider the risks of a choice before making a decision
- Think about all the information I have about the different choices
- Think of past choices when making new decisions

Items adapted from: Perkins & Mincemoyer, 2002.

Statistical Properties:

Alpha	Mean	Standard Deviation	Minimum	25th Percentile	75th Percentile	Maximum
0.77	3.06	0.64	1	2.60	3.60	4



Problem Solving

The Problem Solving Scale was computed to range from one to four, with four indicating that on average participants said they always do the following:

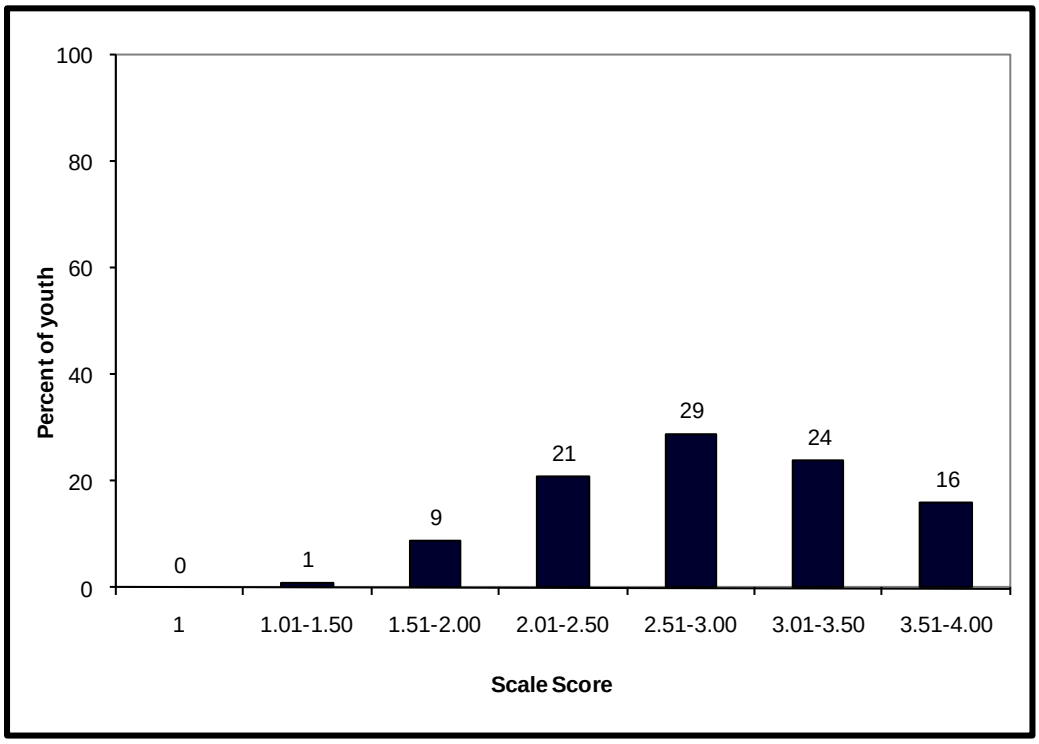
When solving a problem…

- I first figure out exactly what the problem is
- I try to determine what caused it
- I do what I have done in the past to solve it
- I compare each possible solution with others to find the best one
- After selecting a solution, I think about it for a while before putting it into action
- Once I have solved a problem, I think about how my solution worked

Items adapted from: Perkins & Mincemoyer, 2002.

Statistical Properties:

Alpha	Mean	Standard Deviation	Minimum	25th Percentile	75th Percentile	Maximum
0.74	2.94	0.60	1	2.50	3.33	4

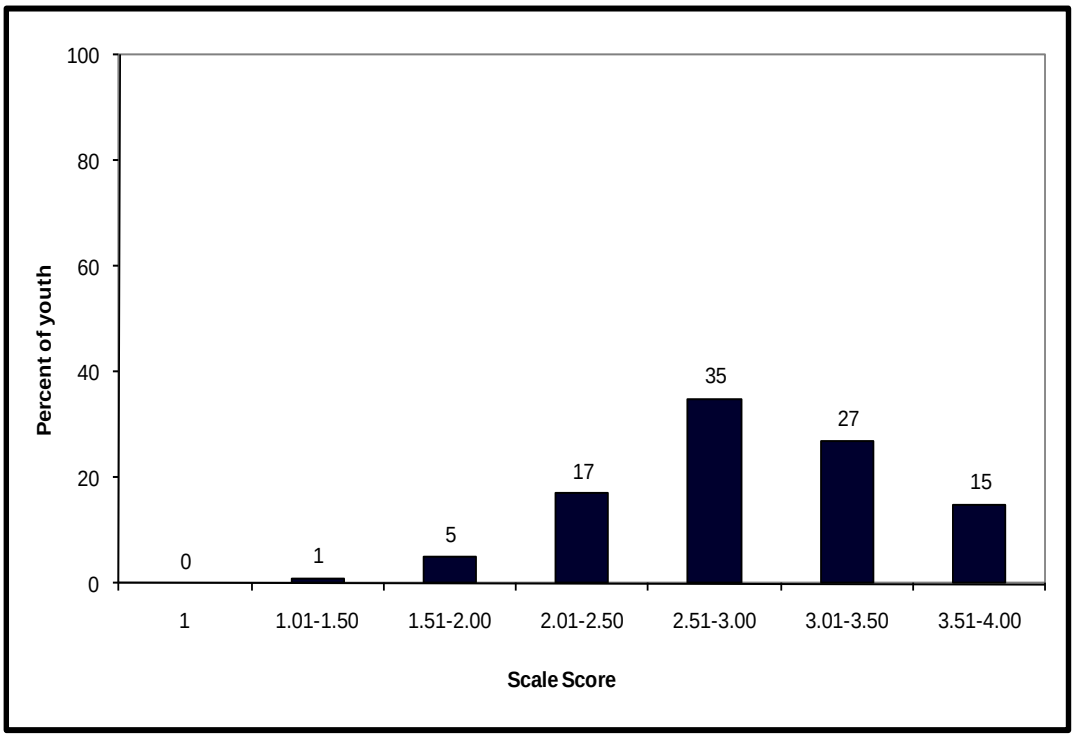


Noyce Enthusiasm Scale

The Noyce Enthusiasm Scale was computed to range from one to four, with four indicating that participants strongly agreed with the following statements:

- Science is something I get excited about
- I like to take things apart to learn more about them
- I like to participate in science projects
- I'd like to get a science kit as a gift (for example, a microscope, magnifying glass, a robot, etc.)
- I like to see how things are made (for example, ice-cream, a TV, an iPhone, energy, etc)
- I am curious to learn more about science, computers or technology
- I like to watch programs on TV about nature and discoveries
- I like to work on science activities
- When I grow up and have kids, I will take them to a science museum
- I want to understand science (for example, to know how computers work, how rain forms, or how airplanes fly)
- I enjoy visiting science museums or zoos
- I get excited learning about new discoveries or inventions
- I like reading science magazines
- I pay attention when people talk about recycling to protect our environment
- I am curious to learn more about cars that run on electricity
- I get excited to find out that I will be doing a science activity
- I enjoy reading science fiction books
- I like science
- Science is boring *(item was reverse-coded)*

Alpha	Mean	Standard Deviation	Minimum	25th Percentile	75th Percentile	Maximum
0.91	2.93	0.55	1	2.56	3.33	4



Science Process Skills Inventory, Youth Ages 13 to 18

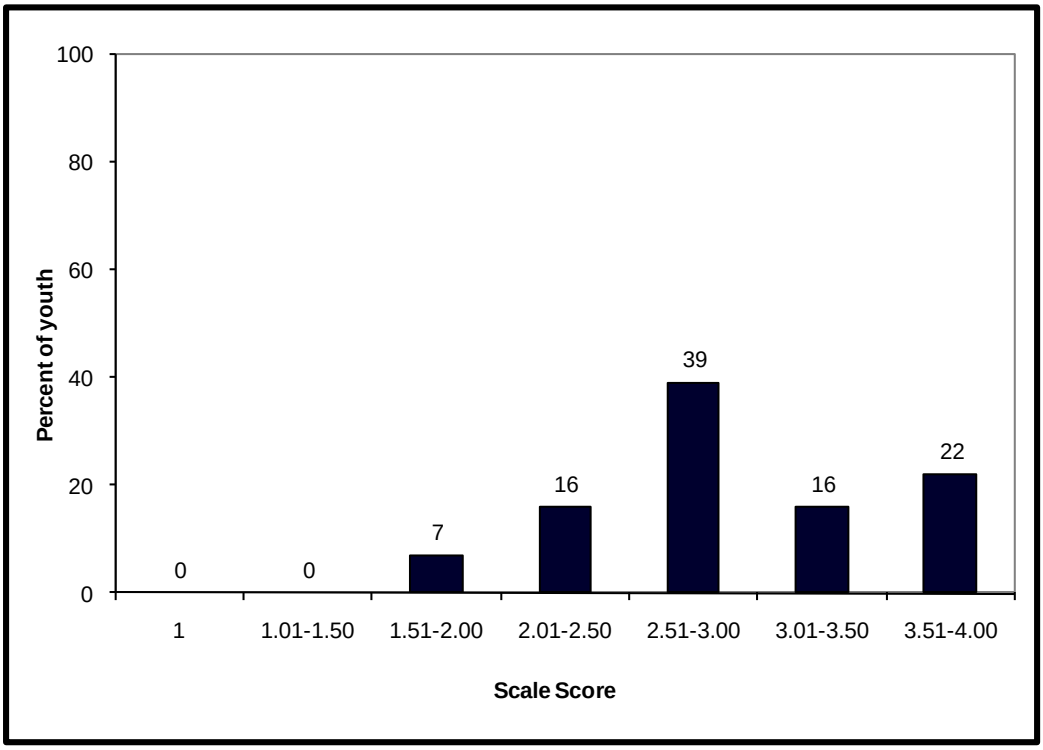
The Science Process Skills Inventory was computed to range from one to four, with four indicating that on average, participants said the following statements are always true:

- I can use scientific knowledge to form a question
- I can ask a question that can be answered by collecting data
- I can design a scientific procedure to answer a question
- I can communicate a scientific procedure to others
- I can record data accurately
- I can use data to create a graph for presentation to others
- I can create a display to communicate my data and observations
- I can analyze the results of a scientific investigation
- I can use science terms to share my results
- I can use models to explain my results
- I can use the results of my investigation to answer the questions I asked

These questions were only asked of youth ages 13 and older.

Items adapted from: Arnold & Bordeau, 2009.

Alpha	Mean	Standard Deviation	Minimum	25th Percentile	75th Percentile	Maximum
0.91	2.98	0.59	1.73	2.55	3.4	4



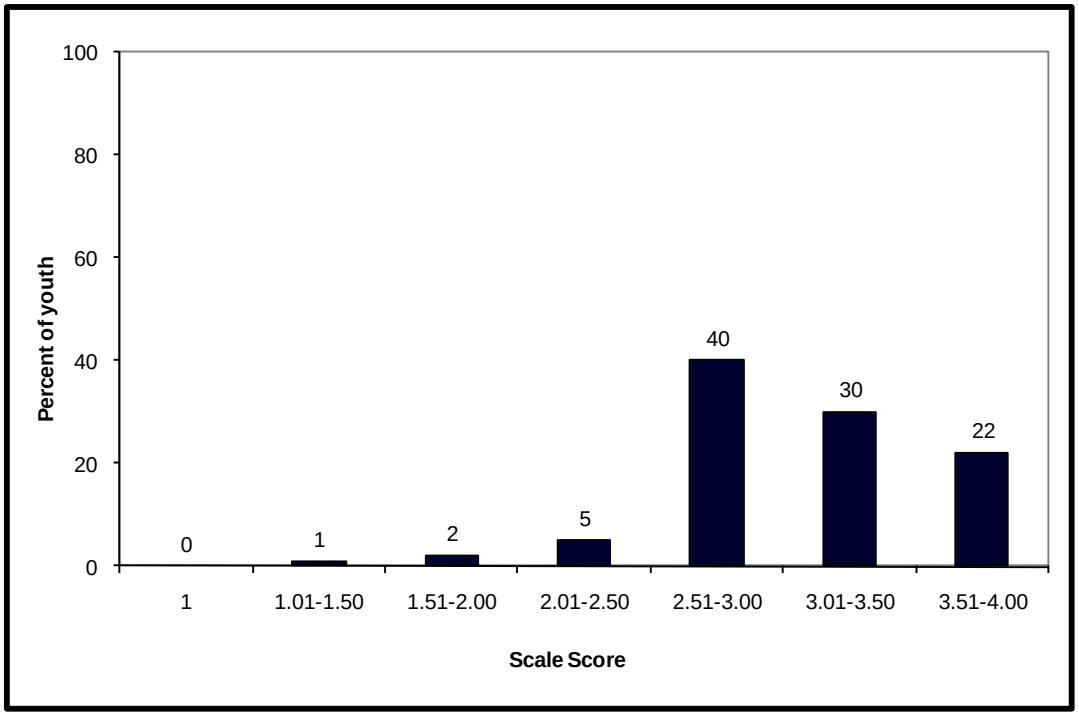
Program Benefits & Opportunities Scale

The Program Benefits and Opportunities scale was computed to range from one to four, with four indicating that on average, participants strongly agree that they can do the following in their 4-H program or project:

In this 4-H program or project, I can…

- Do experiments
- Do hands-on science activities
- Solve problems
- See science in a fun way
- Learn about careers
- Serve my community
- Learn with my friends
- Get answers to my questions from leaders
- Tell a group of people about something I learned or made

Alpha	Mean	Standard Deviation	Minimum	25th Percentile	75th Percentile	Maximum
0.82	3.10	0.51	1	2.78	3.44	4



Program Climate Scale

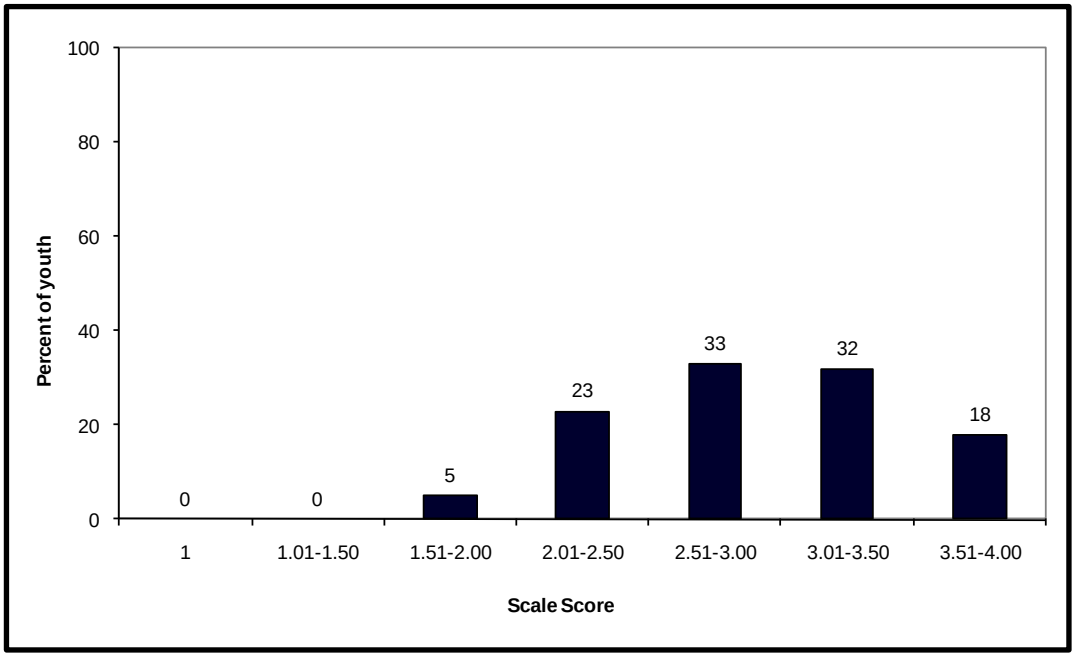
The Program Climate scale was computed to range from one to four, with four indicating that on average, participants said the following things are always true about their program or project:

In this 4-H program or project…

- I feel safe and respected
- I am afraid I will be embarrassed or put down *(item was reverse-coded)*
- All kinds of kids are welcome
- Adults listen to what I have to say
- I feel comfortable going to adults for advice
- Other kids care about me
- I feel like I can make a difference
- I am encouraged to take responsibility
- It is OK to make mistakes

Items adapted from: Silliman, 2008.

Alpha	Mean	Standard Deviation	Minimum	25th Percentile	75th Percentile	Maximum
0.75	3	0.51	1.33	2.67	3.41	4



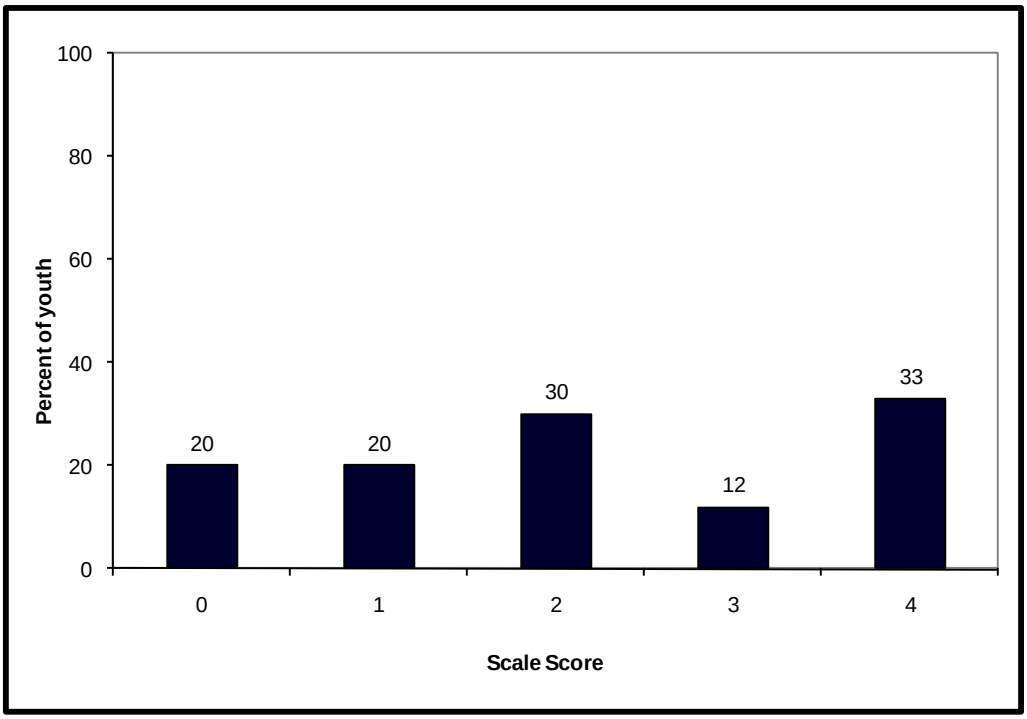
Community Science Scale

The Community Science Scale was computed to range from one to four, with four indicating that youth participated in all of the following activities within the past year:

- Helped with a community service project that relates to science (for example: planted trees or gardens, road or stream clean-up, recycling)
- Used science tools to help the community (for example: mapped with GIS, tested water quality)
- Taught others about science (for example: demonstrated, gave presentation at community meeting or at school)
- Organized or led science-related events (for example: science fair, environmental fair)

Items adapted from: Silliman, 2010.

Alpha	Mean	Standard Deviation	Minimum	25th Percentile	75th Percentile	Maximum
0.64	1.82	1.27	0	1	3	4



Appendix D
2005 and 2009 National Assessment of Educational Progress Survey Items Used on the YEAK Survey

How much do you agree or disagree with the following statements?	Year	4th Grade	8th Grade	12th Grade
I like science	2005	X	X	X
	2009			
I am good at science	2005	X	X	X
	2009			
Science is boring	2005	X	X	X
	2009			
Science is useful for solving everyday problems	2005	X	X	X
	2009			
Science is one of my favorite subjects	2005			
	2009		X	X
I do science-related activities that are not for schoolwork	2005			
	2009		X	
I take science only because I have to	2005			
	2009		X	X
I take science only because it will help me in the future.	2005			
	2009		X	X
When I graduate from high school, I would like to have a job related to science.	2005			
	2009			X

Exhibit reads: In 2005, the item “I like science” was asked to fourth-, eighth-, and twelfth-grade youth surveyed in the NAEP Science assessment. The item was not asked at any grade in 2009.

Appendix E
Narrative Comparison of 2010 and 2011 YEAK Survey Data

Overview

The comparisons detailed here examine the differences and similarities between youth responses on the 2010 and 2011 YEAK surveys. Each comparison is a general statement about the overall trends in the two datasets; no statistical tests were performed to assess any differences between the two samples because we used different sampling methods in 2010 and 2011.

Demographics

- Youth in the 2010 and 2011 YEAK samples hailed from similar racial and ethnic backgrounds. Roughly equal numbers of males and females participated in each survey, but the 2011 sample had slightly more younger youth (ages 9 to 12) than the 2010 sample. Fewer youth in the 2011 sample attended public school.

Youth Experiences in 4-H & 4-H Science

- In 2011, a slightly higher percentage of youth reported being in 4-H for three years or more. More youth in the 2011 sample had been in their projects for eight months or more, and these youth also reported spending more time each week on their projects.

Program Benefits & Climate

- Youth responded similarly on their reasons for joining 4-H. Youth in each of the two samples also agreed on the opportunities they have in their science projects, favorite characteristics of their programs, and overall program climate.

Life Skills

- In general, youth gave similar accounts of their problem solving, critical thinking, and decision making skills.

Science Process Skills

- Among respondents ages 9 to 12, youth in the two samples reported similar science process skills. Generally, the same was true among youth ages 13 to 18.

However, more youth in the 2011 sample reported that they can always or usually use the results of an investigation to answer the questions they asked.

Attitudes & Enthusiasm toward Science

- Youth in each of the two samples shared similar attitudes and enthusiasm about science.

Academic Aspirations & Interest in Science Career

- More youth in the 2011 sample want to pursue more education after college than youth in the 2010 sample. Roughly similar numbers of youth said they want to have a science-related career after graduating from high school.

Comparisons Based on Youth Characteristics

- ***Race and ethnicity.*** We cannot compare findings between 2010 and 2011 in regards to race and ethnicity because we used different methods to categorize youth in each year. In 2010 we analyzed the differences between white and African American youth; in 2011 we analyzed the differences between youth whose race or ethnicity is well-represented in science fields and youth whose race or ethnicity is underrepresented in science fields.

- ***Gender.*** Analyses of 2010 youth survey data revealed that a significantly larger percentage of boys reported wanting to pursue a science career than did girls. In 2011 there was no significant difference between the career aspirations of boys and girls. In 2011 boys were more positive than girls on a scale measuring their enthusiasm toward science, but girls gave higher ratings of their own decision making and critical thinking skills than did boys. In 2011 girls also gave higher average ratings to their program's overall climate.

- ***Exposure to 4-H Science.*** In both 2010 and 2011 we found that youth with higher levels of exposure to 4-H Science programming gave higher average ratings of their own life skills than did youth in the low-exposure group. 2010 high-exposure respondents gave a more positive rating of their program environment than did low-exposure youth; in 2011 high-exposure youth gave more positive assessments of the benefits they received from participating in the program.