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 and National 4-H Council introduced an 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. This report examines attitudes towards science held by youth in 4-H Science programs around the country.

With the support of the Noyce Foundation, National 4-H Council has been working with Policy Studies Associates (PSA) since 2009 to evaluate the implementation of this initiative. Evaluators have examined state- and county-level implementation and delivery of science programming; youth engagement in science, attitudes towards science, and knowledge of science; and promising practices used in science programs.

The goals of this report are to describe the characteristics and opinions of youth in 4-H Science programs around the country as of 2013 and to illustrate the potential effects of 4-H Science programs on youth. These descriptions of youth are intended to inform 4-H about the youth it is serving and to help identify areas where improvement and support may be needed.

A total of 418 youth ranging from 9 to 18 years of age completed this year's survey. The survey's program-level response rate was 75 percent, and the youth-level response rate was 61 percent in programs returning surveys. Throughout this report, youth responses from the 2010 and 2011 YEAK surveys are compared with those from this 2013 survey. For selected items, YEAK survey results are also compared with survey results from the National Assessment of Educational Progress to provide a point of reference for 4-H youth's attitudes towards science.

While youth can be involved in more than one type of 4-H program, youth in this year's sample were more likely than youth in previous samples to have participated in clubs and less likely to have participated in after-school programs. Overall, participants surveyed in 2013 reported spending less time in their 4-H programs each week than did 2010 and 2011 respondents. Many of the youth surveyed in 2013, unlike those in previous samples, had extensive prior 4-H experience. These differences in 4-H experiences and participation hours likely reflect differences in the type of programming and frequency of meetings in this sample: community clubs, which were more heavily represented in the 2013 sample, typically meet less frequently during certain times of the year. Additionally, many community club members work on 4-H projects at home, and may not have included that time in their weekly estimate.

As in previous years, youth responded positively about the overall environment of their programs. In addition, relationships with peers and positive experiences with adults were among the favorite characteristics of programs for youth. "I get to do hands-on science activities and projects," "I get to spend time with my friends," and "The adults are caring and kind" were the top three responses in each year of the survey.

Positive involvement in one's community is an important tenet for 4-H as an organization. More than two-thirds of respondents (69 percent) reported that they participated in a science-related service project in the past year, while about half of youth (51 percent) taught others about science. Youth responded similarly to these items in 2010 and 2011.

Overall, the 4-H participants who responded to this survey, like previous groups of surveyed youth, reported being aware of and interested in science activities. Responses suggest that the 4-H participants in this sample are highly engaged in science-related activities and are eager to participate in those activities, especially in informal settings. Although this evaluation 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 interests and engagement in science could be sparked or intensified by 4-H science programming.

Generally, youth in 4-H Science programs were more enthusiastic about science than were their peers surveyed for the National Assessment of Education Progress: 77 percent of the fourth-grade 4-H Science participants agreed with the statement, "I like science," compared with 64 percent of fourth-graders in this national sample. More than half of 4-H Science participants in the eighth grade (64 percent) agreed that science is one of their favorite subjects, compared to 47 percent of 2011 NAEP respondents in the eighth grade. Twelfth-grade youth participating in 4-H Science programs were more likely than NAEP respondents to agree that they would like to have a science-related job when they graduate from high school: 77 percent of 4-H Science participants agreed that they would like to have a science-related job, compared to 37 percent of NAEP respondents.

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. In general, surveyed youth in 4-H Science programs gave similar, positive assessments of their science process skills in 2010, 2011, and 2013. For example, almost all youth ages 9-12 reported that they can write down information correctly (90 percent) or make a chart or picture to show information (85 percent). Older youth participants ages 13 to 18 responded to a similar set of questions about their mastery of certain science process skills.

When asked if they would like to have a job related to science when they graduate from high school, 59 percent of youth agreed or agreed strongly. In 2010, 50 percent of respondents reported wanting a science career, and 2011, 54 percent of respondents did so.

The YEAK survey administered in 2013 yielded answers very similar to those produced in its two previous administrations, in 2010 and 2011. This is noteworthy because for this third administration the evaluation team made substantial changes in the survey sampling methods, allowing the collection of data from a wider range of programs in contrast to the previous sample, which relied on program nominations from the county or state level. The programs sampled for 2013 were more likely to be traditional clubs than those sampled in previous years. The similarities in findings lend weight to the idea that the attitudes and experiences of youth in 4-H Science programs are similar among youth with different types of 4-H experiences.

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Overview of the Initiative and the Evaluation

In 2006, 4-H National Headquarters and National 4-H Council introduced an 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. This report examines attitudes towards science held by youth in 4-H Science programs around the country.

4-H Science programs are intended to help youth build their science skills and knowledge, improve their life skills, and become engaged in their communities through involving youth in experiential and inquiry-based activities. 4-H Science programs are designed to take place in a positive youth development context and to thereby build a sense of belonging and independence among youth.

In order to accomplish the initiatives' goals of expanding and improving Science programming, 4-H has created new curricula and programming, and provided professional development and supports for state and county staff, as well as volunteer leaders.

With the support of the Noyce Foundation, National 4-H Council has been working with Policy Studies Associates (PSA) since 2009 to evaluate the implementation of this initiative. Evaluators have examined state- and county-level implementation and delivery of science programming; youth engagement in science, attitudes towards science, and knowledge of science; and promising practices used in science programs.

The goals of this report are to describe the characteristics and opinions of youth in 4-H Science programs around the country and to illustrate the potential effects of 4-H Science programs on youth. These descriptions of youth are intended to inform 4-H about the youth it is serving and to help identify areas where improvement and support may be needed.

Participating youth surveyed for this evaluation, compared with a national sample of youth, more often reported that they like science, are good at science, and want careers in the field. They reported that they like the opportunities their 4-H Science programs afford them to spend time with their friends and do hands-on activities and projects; they also report that the adults in their programs are caring and kind. The data from 4-H Science participants are drawn from the Youth Engagement, Attitudes, and Knowledge (YEAK) survey (designed for this evaluation); comparative data on youth nationwide come from the National Assessment of Educational Progress. This report elaborates on these survey findings and describes the methods used.

Research Questions

Because the goals of the 4-H Science Initiative are to increase youth interest in and improve youth attitudes toward science-related fields, evaluators have sought to address the following questions about the youth in the sample:

- What are the characteristics of the youth involved in Science Ready programming?
- Do participants' program experiences reflect 4-H positive youth development principles? What do participants like most about their programs?
- Do participants use science to help their communities?
- To what extent are participants engaged in science?
- What are participants' attitudes towards science?
- What science-related skills, abilities, and knowledge do participants have?
- What level of education do participants want to achieve?
- Do participants aspire to pursue career opportunities in science-related fields?
- What factors, if any, are associated with participants' engagement, attitudes, and knowledge of science?

The YEAK survey administered in 2013 yielded answers very similar to those produced in its two previous administrations, in 2010 and 2011. This is noteworthy because for this third administration the evaluation team made substantial changes in the survey sampling methods, allowing the collection of data from a wider range of programs. The newer methods and the rationale for using them are described in more detail in the next section of this report.

Methods

The best way to capture a snapshot of the attitudes held by youth in 4-H Science programs would be to survey a representative sample of participants and use the results to make inferences about the entire population of 4-H Science youth. In turn, creating a representative sample would require information about the population of 4-H Science programs and participants from which to draw this sample. Thus, evaluators' options for understanding the entire 4-H Science population and taking a representative snapshot depend upon the systems for data management that 4-H develops and uses. In each administration of the YEAK survey, the evaluation team has been able to take advantage of advances in 4-H data management and has made progress towards a representative sample. The steps taken in each year, as well as their relationship to 4-H's evolving data tracking capabilities, are described below.

The YEAK survey instrument itself dates back to 2009, when it was developed in a partnership between the evaluators and the 4-H Science Instrument Design Team. The survey draws upon existing surveys from within and outside 4-H (Arnold & Bordeau, 2009; Perkins & Mincemoyer, 2002; Silliman, 2008; and Silliman, 2010). It includes items from the National Assessment of Educational Progress (NAEP), and is part of the Noyce/Harvard PEAR effort to develop common measures for informal science programs.[1] The PSA evaluation of 4-H Science has included three administrations of the YEAK survey: December 2009 to February 2010; May to July 2011; and July 2012 to January 2013.

Sampling Approach in 2013

The aim of this study has been to survey youth in a particular type of 4-H program: those labeled "Science Ready." Science Ready is an important concept that 4-H has introduced and defined during the Science Initiative in order to encourage states and localities to: (1) recognize the science-related activities they are currently operating; (2) improve the quality of those activities in accordance with the Science Initiative's principles; and (3) identify and track the projects and programs that are aligned with these principles and are therefore marked as Science Ready.

Identifying Science Ready programs. As a guide to developing Science Ready programs, 4-H issued a set of guidelines for high-quality science, engineering, and technology programs called the 4-H Science Checklist. Specifically, Science Ready 4-H experiences are to: (1) be based on National Science Education Standards, (2) develop participants' science-related skills and abilities, (3) use positive youth development practices, (4) be 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. In order to survey youth in 4-H Science Ready programs, evaluators needed to obtain a list of such programs operating in each Land Grant University (LGU) area.

Systematically tracking locally organized 4-H clubs and programs poses a data management challenge for states and for 4-H nationally. As part of the Science Initiative, additional information about 4-H experiences was to be tracked: namely, whether a particular 4-H experience was Science Ready. This request from 4-H at the national level to track Science Ready programs was one way to communicate the importance of the concept to state and county level staff.

As is common in building large-scale data systems, different states and localities approached the task using different strategies, at different rates, and with different levels of success. Some insight into the rate of progress comes from the annual 4-H Enrollment Survey (also conducted by this evaluation team), which sought to gather information about the status of 4-H Science Ready programming and youth enrollment nationwide – and to gauge the extent to which LGUs could provide data on these points. In the 2013 Enrollment Survey, 28 out of the 50 responding LGUs provided the number of Science Ready programs operating in their area; 22 LGUs were unable to provide this information. A small number of these 22 LGUs volunteered

[1] PEAR's Assessment Tools in Informal Science (ATIS): http://www.pearweb.org/atis/dashboard/index

the explanation that they could not provide this information because they could not distinguish between Science Ready programs and other science-related activities in their areas (Butler, 2013).

In each administration of the YEAK survey, the evaluation team tried to capitalize on the most complete information available in order to improve the representativeness of the youth sample. For the first two administrations of the YEAK survey, evaluators relied on state specialists and county 4-H agents to provide contact information for Science Ready clubs and programs in their areas in order to create a pool from which to sample.[2] Although evaluators randomly selected programs after the lists had been built, the lists themselves were composed of clubs and programs that were, by necessity, relatively well known to state-level and county-level staff. The nature of these lists meant that past YEAK surveys did not capture a fully representative sample of youth participating in 4-H Science Ready experiences.

In the third survey administration, working with the newly operational ACCESS 4-H data management system, the evaluation team used data entered into that system to identify eligible programs to survey. The ACCESS 4-H system tracks enrollments, individual youth, volunteers, and projects at several levels and is helping to meet 4-H's data needs of tracking youth and adult participation in 4-H programming. By using the ACCESS 4-H system, evaluators were able to create a sample of programs that – unlike in past years – was not a convenience sample. Instead, evaluators were able to build a list of programs that was more complete and included programs that were less well known to state and county staff. Youth in this subgroup of programs were the respondents to the survey.

Selection of LGUs. For participation in 2012-13 survey administration, evaluators selected LGUs from among those that use the ACCESS 4-H system and had entered data on their Science Ready programs and projects. As of the spring of 2012, 35 LGUs had adopted the ACCESS system (out of 65 who had submitted plans to implement the Science Initiative). For the purposes of the YEAK survey, evaluators wanted to survey youth who were participating in Science Ready experiences. At the start of survey administration, 19 LGUs had completed marking the programs and projects in their states as Science Ready. Evaluators therefore selected LGUs from this group of 19 to participate in the YEAK survey. The eight LGUs selected for participation were:

- The University of Connecticut
- Fort Valley State University
- Kansas State University
- The University of Maine
- The University of Missouri
- The University of Nebraska
- Oklahoma State University

[2] In 2009, evaluators surveyed county- and state-level staff in LGUs identified by 4-H and asked them to list Science Ready programs operating in their states and counties. From that list, evaluators randomly selected eligible programs. In 2011, the evaluation team asked state-level staff in a different set of LGUs identified by 4-H to list the Science Ready programs in their states, as well as the science educators who led those programs. Evaluators then surveyed those science educators (county staff and volunteer educators who lead programming) to generate the survey pool of programs, and then randomly selected eligible programs.

- Washington State University

Selection of programs and clubs. For each of the eight participating LGUs, evaluators created lists of eligible clubs from the LGUs' ACCESS 4-H data using the following criteria:

- Adequate contact information for an adult (name and email address or name and phone number)
- Labeled as 'Active'
- Labeled as an organized community club, individual study, or camp. Afterschool groups and school enrichment projects were excluded from the sample because the survey was to be administered in the summer of 2012. (Ultimately, survey administration extended into early 2013, but the original sample was not changed.)
- 50 percent or more of the projects were labeled Science Ready
- 50 percent or more participants were age 9-18

The criterion of "50 percent or more of projects were labeled Science Ready" deserves some further explanation. Although the 4-H Science Checklist is framed as though individual clubs or groups would be assessed based on its criteria, the Science Ready designation in ACCESS 4-H is not given to clubs or programs. Instead, individual projects – curricula or activities dealing with particular topic areas, such as Animal Science or Robotics – are designated by state and county staff as Science Ready. Furthermore, projects are linked to *youth* in the database, not to clubs, because youth can undertake projects on their own within their 4-H club. But rather than identifying and surveying youth individually based on the projects in which they took part, evaluators needed to identify groups of youth for which an adult could facilitate the survey. Therefore, in order to survey groups of youth who were participating in Science Ready projects, evaluators selected clubs in which at least half of the projects that the youth in the club undertook were labeled as Science Ready. This process gave evaluators reasonable confidence that the clubs they would be surveying had a substantial focus on science activities.

In the eight participating LGUs, there were 696 clubs that met the above criteria. After identifying these eligible clubs, evaluators randomly selected five clubs in each state for this survey. If the total number of youth in the selected clubs was very low, evaluators selected additional clubs one at a time, until the number of youth in the state's sample was approximately 100 to 150. Ultimately, 86 clubs were selected to participate in the survey.

However, some of the sampled clubs were not meeting during the survey administration period, and other clubs were ineligible for other reasons. Of the 86 clubs in the sample, evaluators learned that 13 did not have scheduled meetings during the survey administration period, 9 clubs did not re-enroll as 4-H clubs (i.e., they had disbanded), and 3 clubs did not enroll youth in the survey's target population. For nine of the 86 clubs, evaluators were unable to confirm the names and contact information for the club leaders. Therefore, 34 clubs were ineligible for the survey. Of the 52 remaining eligible clubs, 51 agreed to participate in the study.

Program-level response rate. Evaluators received surveys from 38 of the 51 clubs that had agreed to participate, for a program-level response rate of 75 percent.

Exhibit 1
Program-level response rates

LGU	Number of programs sampled	Number of programs surveyed	Programs returning surveys	Program response rate *(in percents)*
Fort Valley State University	2	2	2	100
Kansas State University	11	10	8	80
Oklahoma State University	5	5	5	100
The University of Connecticut	15	13	6	46
The University of Maine	20	10	8	80
The University of Missouri	12	7	5	71
The University of Nebraska	10	3	3	100
Washington State University	11	1	1	100
Total	*86*	*51*	*38*	*75*

Exhibit reads: Of the two Fort Valley State University 4-H Science programs that were sent surveys, two programs returned surveys.

Youth-level response rate. Evaluators requested that club leaders administer the survey to all youth between the ages of 9 and 18 who were present on the designated survey administration day(s). In order to ensure that the responding youth would be representative of the youth in their clubs, evaluators emphasized the importance of administering the surveys to all youth, regardless of their science abilities or engagement in the program.[3] Evaluators also asked club leaders to report the number of youth, on average, who attend their club meetings. Based on those responses, evaluators calculated that 686 youth attended the 38 programs that returned surveys. Of these 686 youth, 418 returned surveys, for a response rate of 61 percent. (In the 51 programs that agreed to participate in the survey, there were a total of 846 youth.)

[3] Three out of the eight LGUs that participated in the survey required that programs obtain either active or passive consent from parents of participants before the survey could be administered.

Exhibit 2
Youth-level response rates

LGU	Number of youth surveyed *(52 programs)*	Number of youth in programs that returned surveys *(38 programs)*	Completed youth surveys	Youth-level response rate *(out of 38 programs, in percents)*
Fort Valley State University	170	170	109	64
Kansas State University	147	127	87	67
Oklahoma State University	72	72	36	50
The University of Connecticut	179	93	56	60
The University of Maine	97	82	54	66
The University of Missouri	106	67	46	70
The University of Nebraska	55	55	28	51
Washington State University	20	20	2	10
Total	*846*	*686*	*418*	*61*

Exhibit reads: 170 youth were surveyed in the Fort Valley State University area. 109 completed surveys for a response rate of 64 percent in programs that returned surveys.

Generalizability of data. The list of programs for this year's survey administration was more comprehensive than in past years, and included all programs listed as Science Ready in the chosen states regardless of their visibility to state and county staff. This sampling method is therefore an improvement on the methods used in past years, and the survey data therefore better represent the Science Ready programs in the states participating in the evaluation.

While the ACCESS data system provided a path to a more comprehensive sample of programs, including clubs that a survey administrator otherwise would not have found, using ACCESS to generate a sample of programs necessitated different survey administration procedures from those used in past years. It was necessary to make more concerted efforts to contact and gain cooperation from these programs, compared with the efforts needed to contact the relatively well-known programs sampled by convenience (who often have stronger connections to state and county staff).

As the number of LGUs using ACCESS increases, and LGUs in general improve the completeness of their Science Ready data, procedures like those followed in this survey administration should yield results that are more representative of Science Ready programs across the country.

Comparisons Made and Statistical Tests Employed

This report provides both descriptive statistics and analyses of the relationships between various items from the youth survey. Evaluators used two approaches to identify associations between youth characteristics and youth survey responses. First, evaluators used multiple regression analysis to determine the relationship between youth characteristics and their survey responses. In addition to multiple regression analysis, evaluators compared the average scale score of survey items by demographic characteristics using a t-test to compare means.

A threshold of $p<0.05$ was used to identify statistically significant findings, and an effect size was computed 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 0.21; comparisons or associations below this threshold were considered too weak to warrant reporting.

Throughout this report, youth responses from the 2010 and 2011 YEAK surveys are compared with those from the 2013 survey. Although we cannot make statistical comparisons from year to year because of the different sampling methods used in each year, we can make general statements about differences that appear to be substantive.

Because of the greater proportion of traditional community clubs that were included in the survey this year as compared to past years, the similarities and differences between this year's results and those from past years are potentially important for describing the groups of youth themselves, and for interpreting the survey results in light of this year's more comprehensive sampling strategy. Overall, analyses showed that the attitudes that youth in this sample held towards science, and the experiences they reported having in their programs, were similar to those of youth in past survey samples, thereby lending weight to the idea that the attitudes and experiences of youth in 4-H Science programs are similar across different types of 4-H programs – and among youth in both programs with greater or lesser visibility at the state and county levels.

For selected items, 2013 survey results are also compared with NAEP results to provide a point of reference for 4-H youth's attitudes towards science. Because of the large differences in the sizes of the weighted NAEP samples and the 4-H Science sample, statistical comparisons in past years, while significant, did not yield effect sizes large enough to meet this evaluation's threshold. For this reason, we did not perform these statistical comparisons this year. As in past years, the NAEP/4-H comparisons should be interpreted as anecdotal evidence of the level of interest that 4-H Science participants have in science.

4-H Science Participants

The 4-H Youth Development Program, with support from the Noyce Foundation, began the 4-H Science Initiative with the goals of engaging more young people in science-related fields and increasing the number of youth pursuing higher education and careers in STEM. The YEAK study provides insight into the population served by 4-H Science programs, their experiences, their attitudes toward science and related fields, how they engage in science in their communities, and their aspirations. While the findings presented in this report reflect a sample of youth participating in 4-H, this report may contribute to the national dialogue on science education in other informal learning environments and on the science engagement and skills of participating youth.

In this report, we first describe the characteristics of surveyed youth involved in Science Ready programming, including their demographic backgrounds and their exposure to 4-H programming. We then address youths' reports of their experiences in their 4-H programs, their engagement in science, attitudes towards science, and report their ratings of their own skills and abilities. Finally, we describe participants' educational and career aspirations.

Demographics

A total of 418 youth ranging from 9 to 18 years of age completed the survey. Sixty-six percent of responding participants were between the ages of 9 and 12. Females comprised the majority of the sample (56 percent).

Seventy-six percent of survey respondents reported their race or ethnicity as white, 19 percent as African American, 4 percent as Native American, 3 percent as other, 2 percent as Hispanic/Latino, 2 percent as Asian, and less than 1 percent as Native Hawaiian/Other Pacific Islander. Five percent of youth selected more than one race/ethnicity.

Based on demographic reports from 22 LGUs in fall 2012,[4] the percentages of white, Native Hawaiian, and Asian participants who responded to the survey are comparable to the percentages of youth in those demographic groups in 4-H Science Ready programs overall (in the 22 LGUs), but there were more African American and Native American participants in the respondent group than in 4-H Science overall. In the 22 LGUs that provided data on the racial and ethnic background of youth, 73 percent of participants were white, 6 percent African American, 5 percent more than one race, and 1 percent each Native American, Asian American, and Native Hawaiian (Butler, 2013). Six percent of participants in the 22 reporting LGUs were Hispanic/Latino.

The level of education a child's mother achieved has been found to have a strong influence on a variety of youth outcomes (Haveman, Wolfe, & Spaulding, 1991). For the 4-H participants who completed the survey, 69 percent said that their mothers had attended college or

[4] In fall 2012, evaluators surveyed state program leaders and Science liaisons in the 65 LGUs that submitted plans of action to implement the Science Initiative. These state leaders were asked to report enrollment figures from their most recent program year (2011-12), including demographic information about participants.

gotten more education after college, 18 percent reported that their mothers had attended high school or grade school, and 13 percent did not know. (Because the sizes of these groups were so different, evaluators did not analyze the survey results based on this variable.)

Exposure to 4-H Science

The lengths and types of youths' experiences with 4-H may affect their attitudes toward science and their career aspirations. Knowledge of youths' prior involvement with 4-H and their experiences with these 4-H science programs are important factors not only in describing the youth surveyed but also in understanding their attitudes toward science and their aspirations.

Delivery mode. 4-H offers several different programming models in which youth can participate. The 2012 4-H Enrollment Survey provided a snapshot of the types of opportunities available to youth across all 4-H Science programs (Butler, 2013). While these data do not identify the number of youth involved in each type of program, they provide insight into the ways 4-H Science programs engage youth nationally. Among the 29 LGUs in 2012 that could provide information about the delivery modes employed by programs in their states, clubs, including community clubs and special interest clubs, comprised about half of the programs available. (Members of special interest clubs share a common interest and focus on a single topic, while 4-H clubs, also known as community clubs, take part in a variety of activities over time.)

Exhibit 3
4-H Science Enrollment Survey
Science Ready program delivery modes *(N=29 LGUs)*

	Number of programs	Percent of programs
4-H club	379	29
Special interest club	295	22
School enrichment	280	21
4-H afterschool	263	20
Day camp	60	4
Residence camp	51	4
Self-directed project	8	< 1
Other delivery method	5	< 1
Academic camp	1	< 1
Total	**1,342**	**100**

Exhibit reads: Across the 29 LGUs able to provide this information, 379 programs, or 29 percent, were 4-H clubs.

This year's survey respondents may represent a different type of 4-H experience than youth surveyed in previous years. In 2013, a greater percentage of responding youth had

participated in clubs than had respondents in past years, and fewer had participated in afterschool programs (Exhibit 4).

In the 2013 YEAK survey, youth reported participating in a range of 4-H programming, with the majority (76 percent) involved in clubs at some point in their 4-H careers (Exhibit 4). Forty-eight percent of participants reported participating in local fairs and events, and 42 percent were involved in at-home projects. While youth can be involved in more than one type of 4-H program, youth in this year's sample were more likely than youth in previous samples to have participated in clubs.

These differences were primarily due to the types of programs that were sampled in 2013: afterschool and school enrichment programs were excluded for scheduling reasons. (Since survey administration was originally scheduled for the summer, such school-based programs were excluded from the sample.)

Exhibit 4
Youth involvement in 4-H programming, 2010-2013

Program type	Percent of respondents		
	2010 *(n=1,000)*	**2011** *(n=400)*	**2013** *(n=396)*
Clubs	55	46	76
After-school programs	42	33	14
Local fairs/events	32	42	48
Working on my projects at home	27	41	42
Community service projects	27	31	40
Camps	15	40	29

Exhibit reads: In the 2010 survey, 55 percent of respondents were involved in 4-H clubs, compared with 46 percent in 2011 and 76 percent in 2013.

Length of time as a 4-H member. 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 2013, unlike in previous samples, had extensive prior 4-H experience. Thirty-one percent of 2013 participants reported that this was their second year in 4-H, and 43 percent reported that they had been in 4-H for three or more years. About a quarter of survey participants were new to 4-H (27 percent). In contrast, 41 percent of 2010 survey respondents were new to 4-H, as were 44 percent in 2011. One might speculate that the after-school programs that were more heavily represented in past YEAK surveys have attracted a larger proportion of new youth to 4-H than have the traditional clubs that made up the bulk of this year's program sample. Alternatively, it is possible that the clubs and programs nominated by LGUs and county agents in prior years were attracting notice in part because of their growing enrollments of new youth.

In 2013, 37 percent of respondents reported that they had participated in another 4-H program or project related to science in addition to their current program or project, compared to 36 percent in 2011 and 25 percent in 2010.

Twenty-six percent of 2013 respondents reported that they have been in their current science program for a month or less. Thirty-seven percent have been participating for 2 to 4 months, 2 percent for 5 to 7 months, and 35 percent for eight months or more. These responses are similar to those from participants in 2010 and 2011.

Extent of weekly involvement. Overall, participants surveyed in 2013 reported spending less time in their 4-H programs each week than did 2010 and 2011 respondents. These differences in 4-H experiences and weekly participation hours may reflect differences in the type of programming and frequency of meetings in this sample: in 2013, the sample consisted mainly of community clubs that meet less frequently during certain times of the year than the afterschool programs and school enrichment programs that typically meet weekly or more often during the school year. In addition, many community club participants work on their 4-H projects at home – as shown in Exhibit 4 above, 42 percent of respondents in 2013 did so – but may not have included that time in their estimate of weekly program involvement.

Sixty-five percent of participants in 2013 reported that they spend one hour or less each week in their current 4-H program; 35 percent spent more than one hour each week. In contrast, in the 2011 administration of the survey, 63 percent of respondents spent more than one hour each week in their program. In 2010, 65 percent of respondents spent more than one hour each week in their program.

Science Program Environment and Benefits

Informal learning programs, like those offered as 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. As outlined in the 4-H Science Checklist and logic model, 4-H expects science programs to situate activities in a positive youth development context based on 4-H's Essential Elements of Positive Youth Development: mastery, independence, belonging, and generosity. The evaluation is interested in learning whether youth in 4-H Science programs report a sense of belonging in their programs and if they experienced activities led by caring adult staff, in accordance with the above youth development principles. Youth responses may illuminate what attracts youth to science programs and what features encourage ongoing participating in these programs.

As in previous years, youth responded positively about the overall environment of their programs. Ninety-five percent of surveyed youth strongly agreed or agreed that all kinds of kids were welcome in their programs, and 89 percent reported that they feel safe and respected in their programs. Eighty-eight percent of youth reported that the adults listened to what they have to say, and 79 percent said that they feel like they can make a difference.

Relationships with peers and positive experiences with adults were among the favorite characteristics of programs for youth. When asked to select the three things they liked best about their science program, youth were most enthusiastic about doing hands-on science projects (66 percent), and the relationships they have with others in their programs: 57 percent of respondents said that the opportunity to spend time with their friends was one of their favorite parts of the

program and 32 percent said that the adults were caring and kind was one of their favorite aspects of the program.

Exhibit 5
Favorite characteristics of this science program *(n=375)*

	Percent of Respondents
I get to do hands-on science activities and projects	66
I get to spend time with my friends	57
The adults are caring and kind	32
I get opportunities to demonstrate things I have learned or made in front of others	30
It is a group where I feel like I belong	28
I get to do community service	27
I can use tools and materials here that I don't have at school or at home	22
It is a place where I feel safe	12
I get positive feedback from the adults and other kids	12
I like the curriculum/project book	7

Exhibit reads: Sixty-six percent of respondents selected "I get to do hands-on science activities and projects" as one of the features of their club they like best.

Youth in this sample responded similarly to youth in the 2010 and 2011 samples. "I get to do hands-on science activities and projects," "I get to spend time with my friends," and "The adults are caring and kind" were the top three responses in each year of the evaluation.

Participation in Community Science Activities

Positive involvement in one's community is an important tenet for 4-H as an organization. Participation in 4-H Science programs is intended to increase youths' awareness of opportunities to contribute to society using science skills (according to the logic model). The evaluation therefore sought to describe whether youth in science programs have participated in community science activities.

As shown in Exhibit 6, more than two-thirds of respondents (69 percent) reported that they participated in a science-related service project in the past year, while slightly more than half of youth (51 percent) taught others about science. Less than one-third of respondents said that they used science tools to help the community (27 percent) and organized or led science-related activities (26 percent). Youth responded similarly to these items in 2010 and 2011.

Exhibit 6
Participation in community science activities *(n=386)*

In the past year, I…	Percent of Respondents
Helped with a community service project that relates to science	69
Taught others about science	51
Used science tools to help the community	27
Organized or led science-related events	26

Exhibit reads: Sixty-nine 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.

Engagement in and Attitudes Toward Science

Two of the intended outcomes of the 4-H Science Initiative, as described in the 4-H Science logic model, are to increase youth awareness of science and youth engagement in science. Youth might demonstrate such awareness and engagement through curiosity about scientific phenomena in their daily lives, or as a desire to learn more about technology or engineering.

Overall, the 4-H participants who responded to this survey, like previous groups of surveyed youth, reported being aware of and interested in science activities. Although this evaluation 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 interests and engagement in science could be sparked or intensified by 4-H science programming.

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 data collection efforts.

Responses suggest that the 4-H participants in this sample are highly engaged in science-related activities and are eager to participate in those activities, especially in informal settings (Exhibit 7). The majority of respondents agreed or strongly agreed that they like to see how things are made (85 percent), participate in science projects (84 percent), and that they like to watch television programs about nature and discoveries (77 percent). These responses are similar to those of participants surveyed in 2011 (these questions were not asked in 2010).

Exhibit 7
Noyce Enthusiasm for Science survey items, in percents *(n=388)*

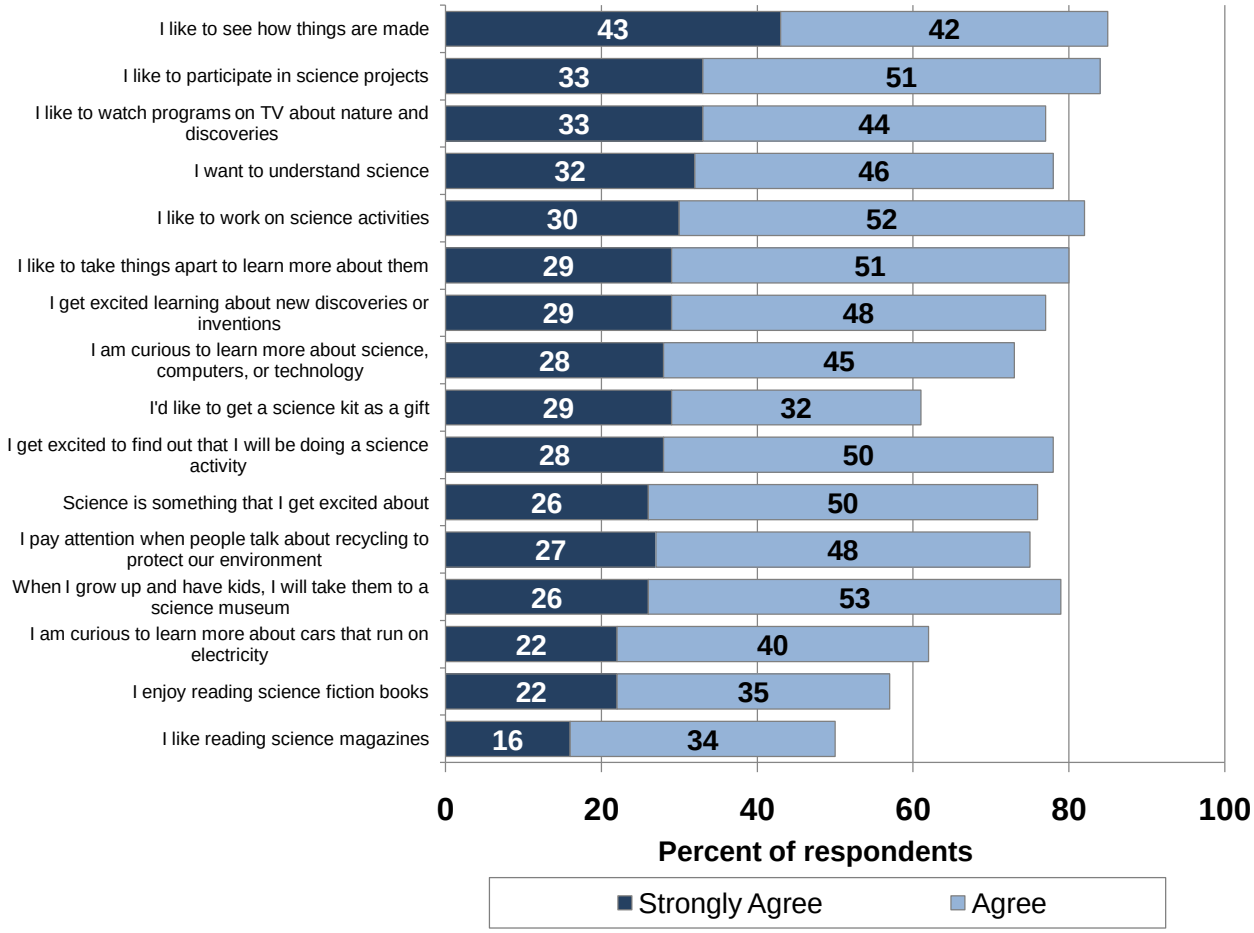

Exhibit reads: Forty-three percent of respondents agreed strongly and 42 percent agreed that they like to see how things are made.

National Assessment of Education Progress (NAEP) science assessment comparisons. The NAEP Science assessment is administered to a nationally representative sample of fourth-, eighth-, and twelfth-grade students approximately every four years and includes a set of items designed to measure respondents' interest in science. To compare 4-H Science participants' attitudes toward science against those of a representative sample of youth, evaluators compared a set of items on the survey that were included in the NAEP Science assessments from 2005, 2009, and 2011.[5]

Generally, youth in 4-H Science programs were more enthusiastic about science than were their peers in the NAEP samples, as was the case in both the 2010 and 2011 surveys of 4-H participants. While the differences between the 4-H and NAEP respondents are apparent, the data do not explain why 4-H youth are more enthusiastic about science. 4-H Science programs

[5] Questions on the NAEP science assessments varied by year and by age group. The most recent NAEP results available are presented here.

may attract youth who have a pre-existing interest in science – indeed, they may have joined 4-H Science programs precisely because they already had a strong interest in science.

Because of the large differences in the sizes of the weighted NAEP samples and the 4-H Science sample, statistical comparisons in past years, while significant, did not yield effect sizes large enough to meet this evaluation's threshold. For this reason, the evaluators did not perform these statistical comparisons this year. As in past years, the NAEP/4-H comparisons should be interpreted 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 enthusiasm for science. Seventy-seven percent of fourth-grade 4-H Science participants agreed that they like science, compared to 64 percent of fourth-grade 2005 NAEP respondents. Eleven percent of 4-H Science participants agreed that science is boring, compared to 18 percent of fourth-grade 2005 NAEP respondents.

Exhibit 8
Fourth-grade 4-H Science and 2005 NAEP respondent attitudes toward science, in percents

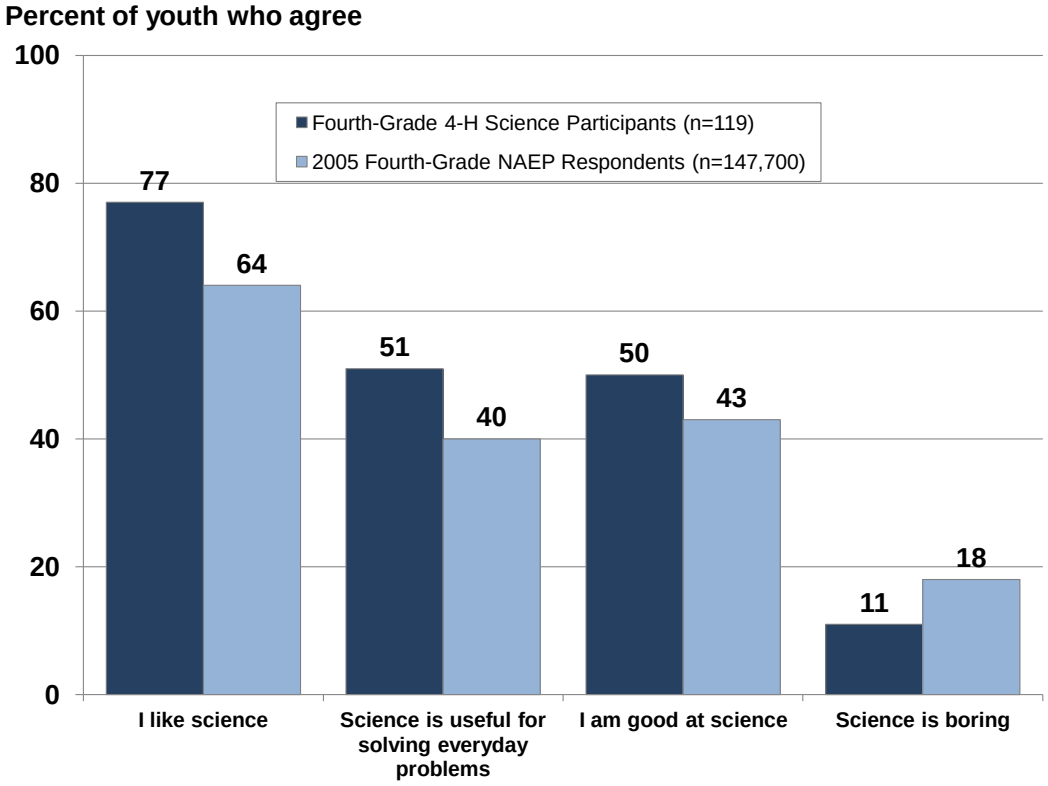

Exhibit reads: Seventy-seven percent of fourth-grade 4-H Science participants agreed that they like science compared to 64 percent of 2005 fourth-grade NAEP respondents.

Eighth-grade results. Like fourth-grade participants, eighth-grade 4-H Science participants were also more enthusiastic about science than were NAEP respondents in the same grade. Seventy-one percent of 4-H Science participants agreed that they like science, compared to 50 percent of NAEP respondents in the eighth grade. Sixteen percent of eighth-grade 4-H Science participants agreed that science is boring, compared to 32 percent of NAEP respondents in the same grade.

Exhibit 9
Eighth-grade 4-H Science and 2005 NAEP respondent attitudes toward science, in percents

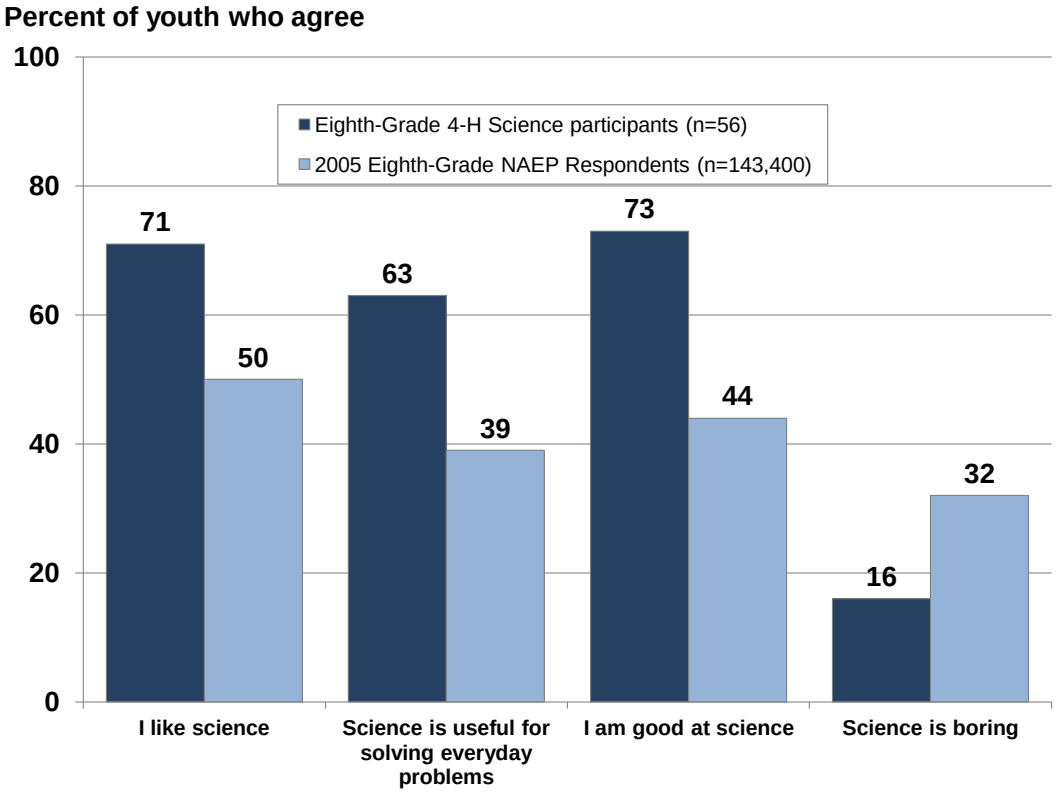

Exhibit reads: Seventy-one percent of eighth grade 4-H Science participants agreed that they like science, compared to 50 percent of 2005 NAEP respondents in the same grade.

4-H Science participants reportedly were more willing to engage in science activities both in and outside of school than were NAEP respondents. Eighth-grade 4-H Science participants who responded to the survey were less likely than NAEP respondents to say that they take science only because they have to (Exhibit 10). More than half of 4-H Science participants in the eighth grade (64 percent) agreed that science is one of their favorite subjects, compared to 47 percent of 2011 NAEP respondents in the eighth grade.

Exhibit 10
Eighth-grade 4-H Science and 2011 NAEP respondent attitudes toward science, in percents

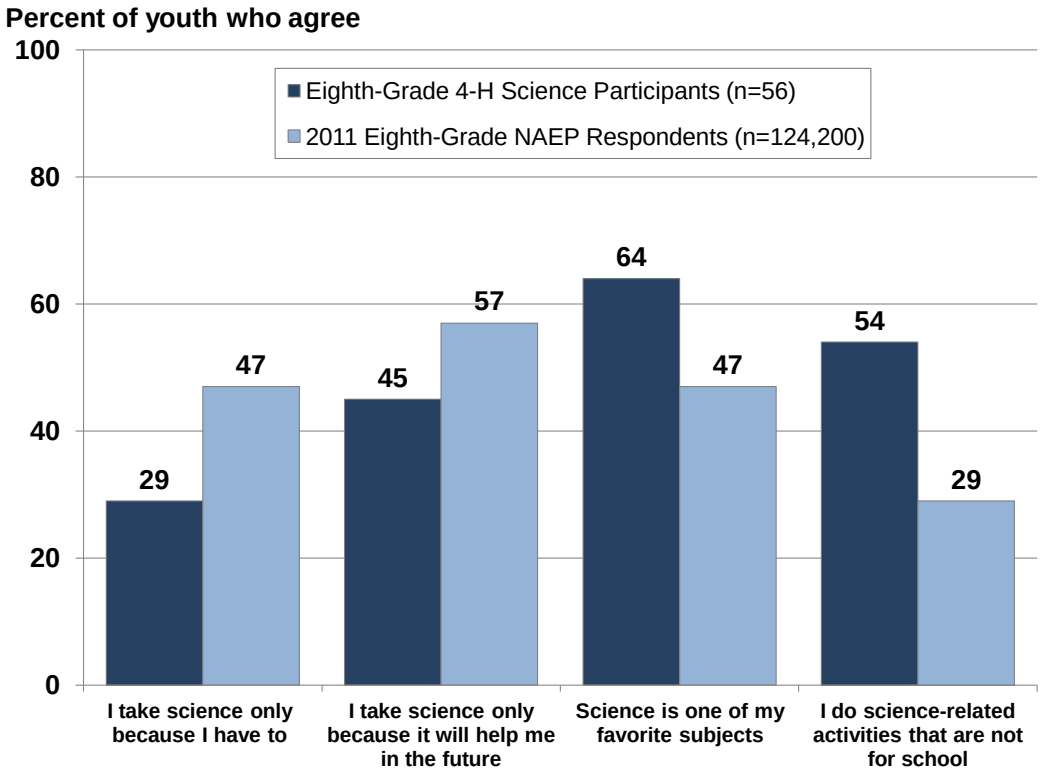

Exhibit reads: Twenty-nine percent of eighth grade 4-H Science participants agreed that they take science only because they have to, compared to 47 percent of 2011 NAEP respondents in the same grade.

Twelfth-grade results. Twelfth-grade youth participating in 4-H Science programs were more likely than NAEP respondents to agree that they would like to have a science-related job when they graduate from high school. As shown in Exhibit 11, 77 percent of 4-H Science participants agreed that they would like to have a science-related job, compared to 37 percent of NAEP respondents. Other measures show small differences between 4-H Science participants and NAEP respondents in the twelfth grade.

Exhibit 11
Twelfth-grade 4-H science and 2009 NAEP respondent attitudes toward science, in percents

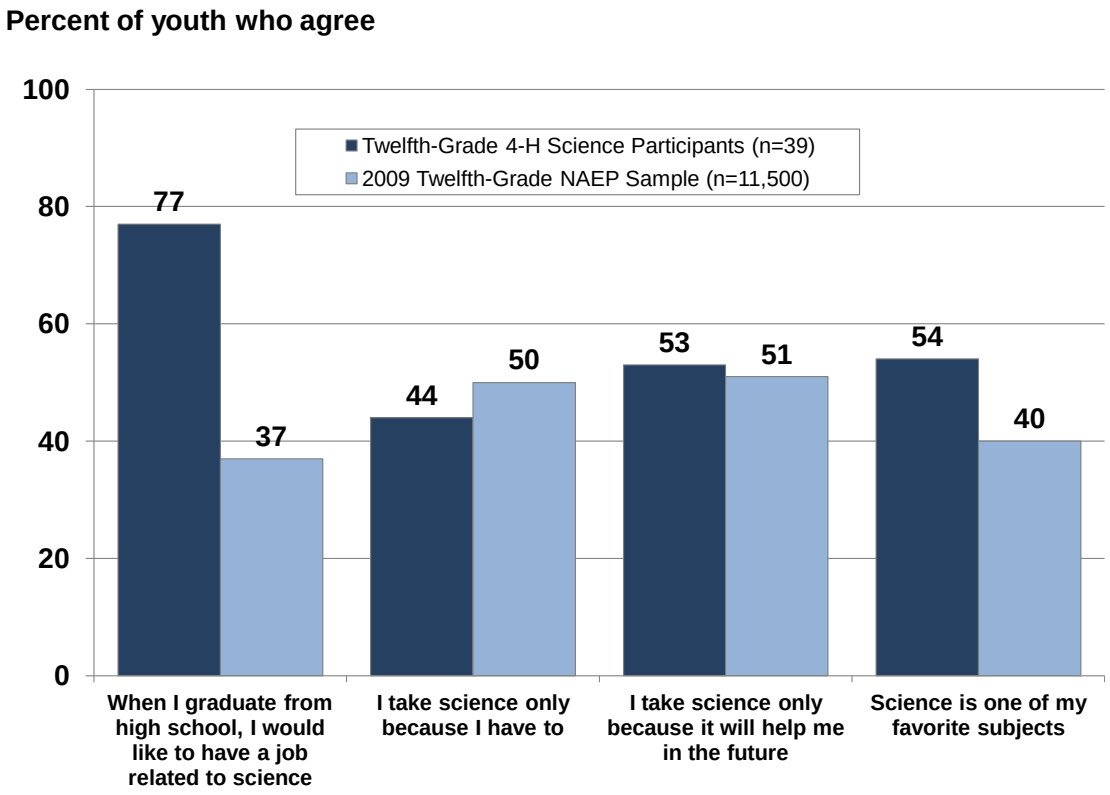

Exhibit reads: Seventy-seven percent of 4-H Science participants agreed that they would like to have a science-related career after graduating high school, compared to 37 percent of 2009 twelfth-grade NAEP respondents.

Compared with the 2013 twelfth-grade 4-H respondents, the twelfth-grade respondents in the 2010 and 2011 4-H Science samples responded more positively to items about taking science in school and enthusiasm toward the subject. Among twelfth-grade youth who participated in a 4-H Science program, 70 percent in 2010 and 73 percent in 2011 said that science was one of their favorite subjects, compared to 54 percent in 2013. Similarly, 32 percent of twelfth-grade 4-H Science participants in 2010 and 31 percent in 2011 said that they took science only because it was required, compared to 44 percent in 2013. These differences could be a result of the greater inclusion of school-based programs in the 2010 and 2011 samples: since youth in the 2013 sample were less likely to be part of a school-based 4-H Science program, they may not have connected their interest in science to classes in school as readily as past respondents did. Even so, in 2013, 77 percent of 4-H participants in 2013 said that they would like a career in science, a slightly larger percentage than in past years (70 percent in 2010 and 67 percent in 2011), suggesting that these youth are still very interested in science. These comparisons are based on very small groups of youth, however: in 2010, only 59 of the survey respondents were ages 17-18, as were 42 in 2011 and 39 in 2013.

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. In general, in 2010, 2011, and 2013, youth gave similar accounts of their problem solving, critical thinking, and decision making skills.

Decision making. Forty-five percent of the youth surveyed reported that, when faced with a decision to make, they always think before making a choice (Exhibit 12).[6] Thirty-eight percent of respondents said that they always think of past choices when making a new decision, while 36 percent said they always think about all of the information they have about different choices.

Exhibit 12
Decision making skills, in percents *(n=398)*

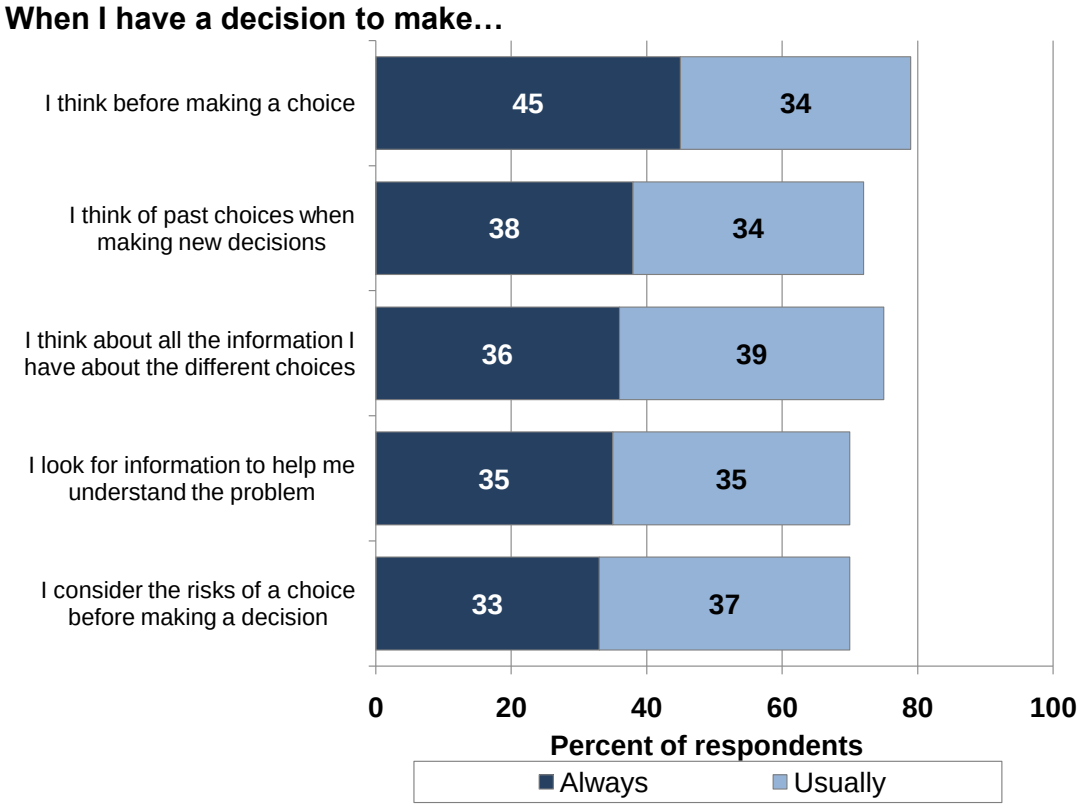

Exhibit reads: Forty-five percent of respondents reported that they always think before making a choice; 34 percent of respondents said that they usually do this.

[6] Survey items on decision making, critical thinking, and problem solving adapted from Perkins & Mincemoyer (2002).

Critical thinking. Forty-one percent of respondents said that they always keep their mind open to different ideas when planning to make a decision. Thirty-one percent said that they always compare ideas when thinking about a topic, and 29 percent said that they can always easily express their thoughts on a problem (Exhibit 13).

Exhibit 13
Critical thinking skills, in percents *(n=393)*

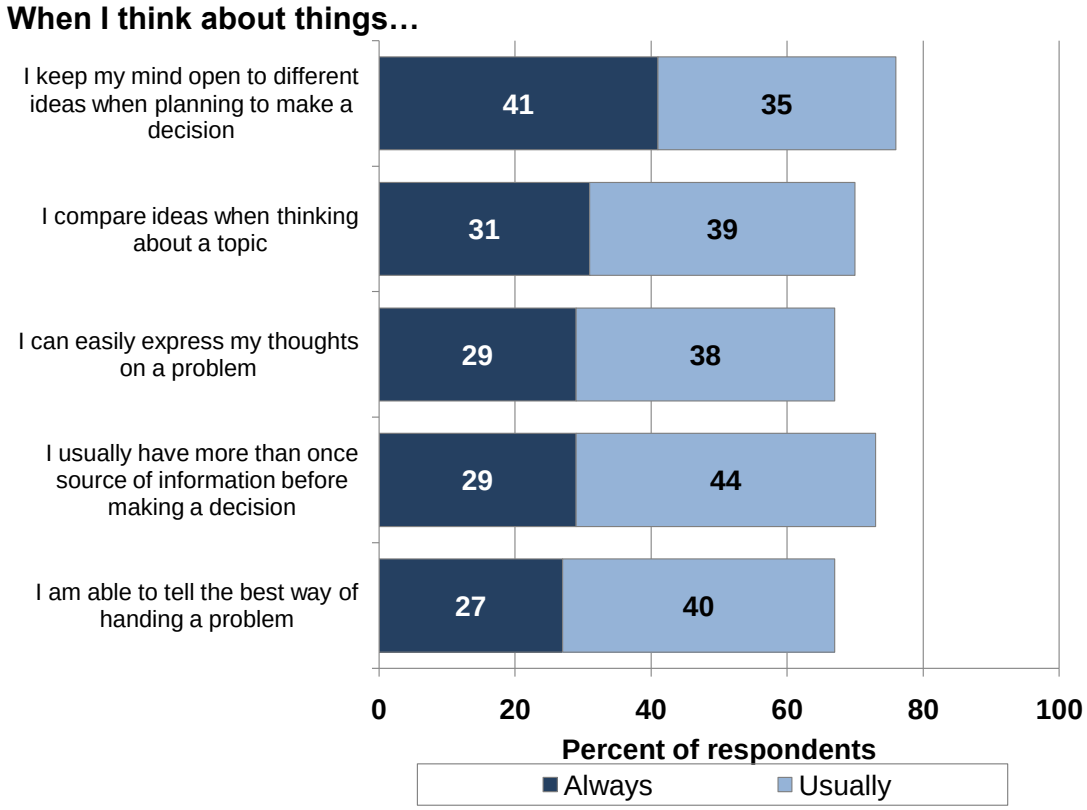

Exhibit reads: Forty-one percent of respondents reported that they always keep their mind open to different ideas when planning to make a decision; 35 percent said that they usually do this.

Problem solving. Forty-two percent of respondents reported that, when solving a problem, they always first try to figure out exactly what the problem is. Thirty-nine percent of respondents said that they always try to determine what caused the problem, and 30 percent said that they always think about how their solution worked once they have solved the problem (Exhibit 14).

Exhibit 14
Problem solving skills, in percents *(n=396)*

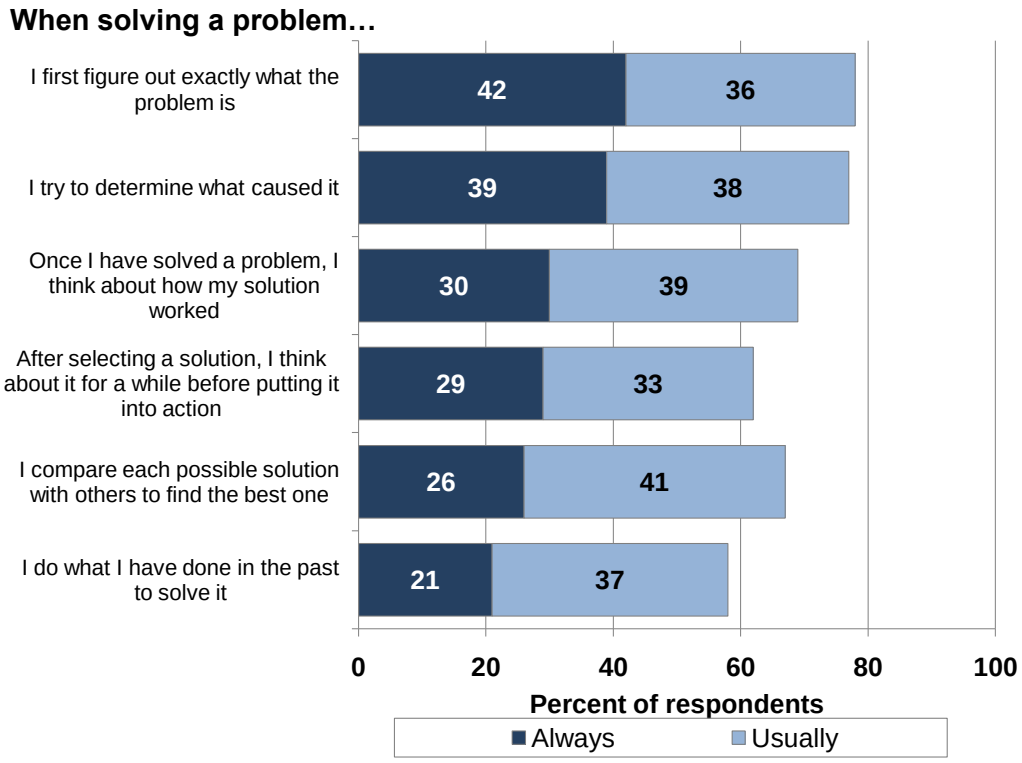

Exhibit reads: Forty-two percent of respondents reported that, when solving a problem, they always first try to figure out exactly what the problem is; 36 percent of respondents said that they usually do this.

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 goals of developing informed citizens with an understanding of how science works reflects national conversations about the importance of STEM education: both science-related skills and the ability to understand scientific concepts are essential for being an informed citizen (National Research Council, 2011).

In general, surveyed youth in 4-H Science programs gave similar, positive assessments of their science process skills in 2010, 2011, and 2013. The survey 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 of youth ages 9-12 and one for youth ages 13-18.

Almost all youth ages 9-12 reported that they can write down information correctly (90 percent) or make a chart or picture to show information (85 percent). Eighty-four percent of youth reported that they can do an experiment to answer a question.

Exhibit 15
Science process skills inventory, ages 9-12 *(n=244)*

I can...	Percent of respondents, ages 9-12
Write down information correctly	90
Make a chart or picture to show information	85
Do an experiment to answer a question	84
Explain why things happen in an experiment	78
Tell others how to do an experiment	73

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

Older youth participants ages 13 to 18 responded to a similar set of questions about their mastery of certain science process skills. As shown in Exhibit 16, most youth reported that they can always or usually: record data accurately (84 percent), create a display to communicate data (81 percent), and use the results of an investigation to answer the question that they had asked (80 percent).

Exhibit 16
Science process skills inventory, ages 13-18 *(n=122)*

I can...	Percent of respondents, ages 13-18
Record data accurately	84
Create a display to communicate my data and observations	81
Use the results of my investigation to answer the questions I asked	80
Ask a question that can be answered by collecting data	80
Use data to create a graph for presentation to others	79
Analyze the results of a scientific investigation	76
Use scientific knowledge to form a question	75
Design a scientific procedure to answer a question	73
Use models to explain my results	73
Communicate a scientific procedure to others	72
Use science terms to share my results	70

Exhibit reads: Eighty-four percent of 4-H Science participants ages 13-18 said that they can record data accurately.

Educational and Career Aspirations

A study of promising practices of 4-H Science programs revealed that the programs profiled implemented a number of strategies to encourage youth to develop an interest in science fields and teach youth about the education pathways to enter those careers (Riley & Butler, 2012).

Informal learning opportunities, like those provided by 4-H science programs, are well-positioned to influence young people's career aspirations. Previous 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, Liu, Maltese, & Fan, 2006). Participating in a 4-H Science program at a young age could lay the groundwork for pursuing a science career later in life.

As in previous years, respondents reported having high educational aspirations. When asked how far they want to go in school, 59 percent of participants said that they want to finish college; an additional 24 percent said that they wanted to get more education after college.

When asked if they would like to have a job related to science when they graduate from high school, 59 percent of youth agreed or agreed strongly. In 2010, 50 percent of respondents reported wanting a science career, and 2011, 54 percent of respondents did so.

Associations between Youth Characteristics and Youth Survey Responses

In addition to providing a picture of the youth involved in Science Ready programming, their experiences in programs, engagement in and attitudes toward science, and their educational and career aspirations, the YEAK study seeks to determine which factors, if any, are associated with the youth outcomes described in the 4-H Science logic model – namely, increased engagement in science, improved attitudes towards science, improved science and life skills, and aspirations towards science careers. The following section discusses associations between youth characteristics – age, amount of exposure to 4-H, gender, and career expectations (i.e., whether students expected to have a science-related career at age 30) – and the following outcomes: enthusiasm for science, program benefits and opportunities, program climate, science process skills, and life skills. Below, we present only the associations that met our reporting requirements for statistical significance and effect size.

Evaluators used two approaches to identify associations. First, evaluators used multiple regression analysis to determine the relationship between youth characteristics and their survey responses. Multiple regression produces an estimate of the impact of each variable included in a model when all other variables in the model are held equal. The following were included as variables in the study's regression models: age, the exposure index (i.e., youth reported attendance and persistence in their 4-H Science program), gender, and career expectations (i.e., whether students expected to have a science-related career at age 30). (Evaluators did not compare responses by race/ethnicity because a large percentage of youth from groups historically underrepresented in the sciences were concentrated in two programs included in the sample.) While the multiple regression models identified associations between select variables and survey responses, the findings did not meet this evaluation's threshold for statistical significance and effect size.

In addition to multiple regression analysis, evaluators compared the average scale score of survey items by demographic characteristics using a t-test to compare means. The following sections describe statistically significant findings that reveal differences among 4-H Science participants' survey responses based on their characteristics. Cohen's d was used as a measure of effect size. Scale properties are detailed in Appendix B.

Gender. 4-H prioritizes increasing the number of women in the sciences. Evaluators compared youth survey responses by gender to illuminate whether 4-H Science programming is reaching all of the youth they hope to serve. Only one statistically significant difference based on gender was detected: on average, girls gave higher ratings to their 4-H program's climate than did boys ($p < 0.01$, effect size=0.29), as they had in 2011. In 2010, youth survey data in revealed a significantly larger percentage of boys reported wanting to pursue a science career than did girls. In 2011 and 2013, evaluators did not find statistically significant differences in the science career aspirations of boys and girls.

Age. Older and younger youth responded differently to several items included in the YEAK survey.[7] Older youth gave more positive evaluations of their decision making skills ($p<0.05$, effect size=0.22) and gave higher ratings to the benefits and opportunities offered by their programs ($p<0.01$, effect size=0.52). Younger youth were more positive than were older youth on a scale measuring their enthusiasm about science ($p<0.05$, effect size=0.27), as were younger youth in the 2011 sample.

Career expectations. Evaluators compared the responses of youth who expected to have a science-related career in adulthood and those who expected to pursue other types of careers. Youth who expected to have a science-related career were more positive on the scale measuring their enthusiasm about science ($p<0.01$, effect size=.31). Youth who expected to have science careers gave higher average ratings of their decision-making skills ($p<0.01$, effect size=0.35), critical thinking skills ($p<0.01$, effect size=.32), and problem solving skills ($p<0.01$, effect size=.32). These youth also gave higher average ratings of their program's overall climate ($p<0.01$, effect size=.46), similar to youth who expected to have a science-related career in the 2010 sample. Youth ages 9 to 12 who expected to have science careers at age 30 were more positive in their assessments of their science process skills compared to youth who did not expect to have a science-related career.

Exposure to 4-H Science programming. The amount of time spent in 4-H Science programs may be associated with attitudes, engagement, and career aspirations related to science. As written in the 4-H Science Checklist, 4-H expects adult leaders to consider whether the frequency and length of club meetings provide enough time for youth to reach the outcomes outlined in the 4-H Science logic model. However, 4-H does not prescribe how often or for how long programs should meet; therefore, meeting frequency and length may vary across programs.

Evaluators 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:

[7] For this analysis, youth were divided into two groups: 9 to 12 year-olds and 13 to 18 year-olds.

- 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?

Respondents were assigned to one of three exposure group – low, moderate, or high – as shown in Exhibit 17.

Exhibit 17
Exposure index *(n=381)*

How many hours do you spend in this program/project each week?	How long have you been participating in this program/project?			
	A month or less	Two to four months	Five to seven months	Eight months or more
More than 3 hours	Low exposure (n=6)	Moderate exposure (n=4)	High exposure (n=1)	High exposure (n=40)
Between 1 and 3 hours	Low exposure (n=12)	Moderate exposure (n=22)	High exposure (n=1)	High exposure (n=49)
One hour or less	Low exposure (n=77)	Low exposure (n=118)	Moderate exposure (n=6)	Moderate exposure (n=45)

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.

Fifty-six percent of respondents were classified as low exposure, 20 percent as moderate exposure, and 24 percent as high exposure. For purposes of significance testing, we only compared youth in the high- and low-exposure groups. Youth survey responses suggest a relationship between exposure and experiences related to 4-H Science programs.

Youth in the high-exposure group gave higher average ratings to their decision making skills ($p<0.05$, effect size=0.27) and gave higher average ratings of their program's benefits and opportunities ($p<0.05$, effect size=0.30) compared to youth in the low-exposure group. Youth in the high-exposure group also gave higher average ratings to their program's climates compared to those in the low-exposure group ($p<0.05$, effect size=0.24). In general, the differences observed between high- and low-exposure youth mirror those found in 2010 and 2011.

As in previous years, these results should be interpreted with care. Youth who spend more time in their 4-H Science program may be more enthusiastic about science compared to youth who spend less time; these youth may 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. The effects of the 4-H science programs themselves cannot be isolated using these results.

Summary of Findings

Surveys of youth in 4-H Science programs from 2010 through 2013 have shown that the youth in these programs are enthusiastic about science, believe they have strong science and life skills, and enjoy the hands-on activities they do and the positive relationships they build through their 4-H programs. For example, when asked to select up to three favorite things about their science program, 66 percent of respondents said that getting to do hands-on science activities and projects was a favorite part. When asked if they would like to have a job related to science when they graduate from high school, 59 percent of youth agreed or strongly agreed. Generally, youth in 4-H Science programs were more enthusiastic about science than were their peers surveyed for the NAEP: 77 percent of the fourth-grade 4-H Science participants agreed with the statement, "I like science," compared with 64 percent of fourth-graders in this national sample.

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 interests and engagement in science could be sparked or intensified by 4-H science programming.

The YEAK survey administered in 2013 yielded answers very similar to those produced in its two previous administrations, in 2010 and 2011. This is noteworthy because for this third administration the evaluation team made substantial changes in the survey sampling methods, allowing the collection of data from a wider range of programs. The programs sampled for 2013 were more likely to be traditional clubs, and had attracted less visibility at the county or state level, than those sampled in previous years. The similarities in findings lend weight to the idea that the attitudes and experiences of youth in 4-H Science programs are similar among youth with different types of 4-H experiences.

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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
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 for each scale:

- **Cronbach's Alpha:** a measure of the internal consistency of the survey scale ranging from 0-1, with higher numbers indicating 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:

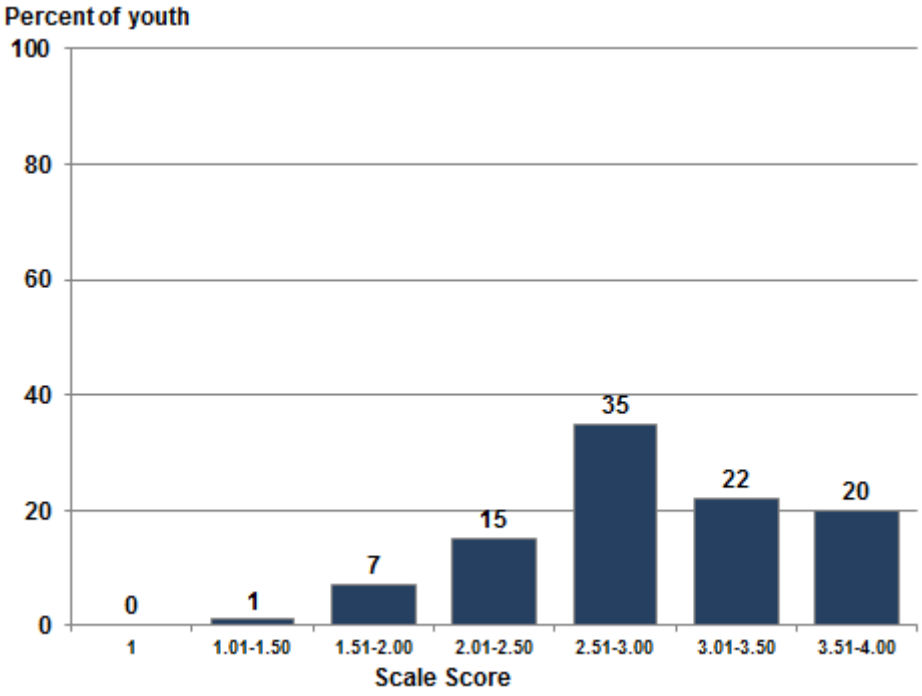
When I think about things I…

- 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	2.98	0.60	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:

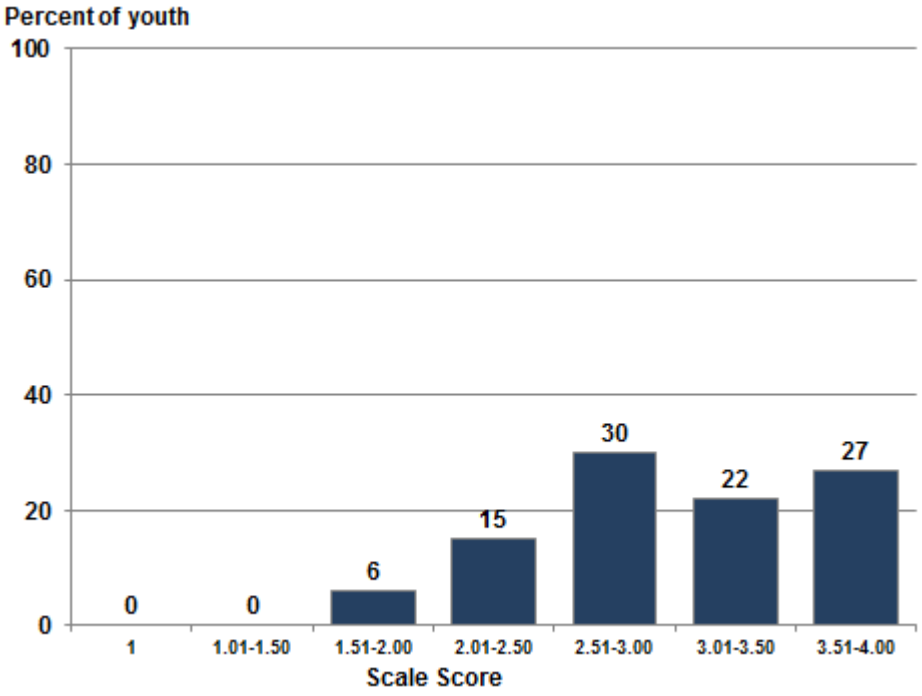
When I have a decision to make I…

- 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	3.07	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:

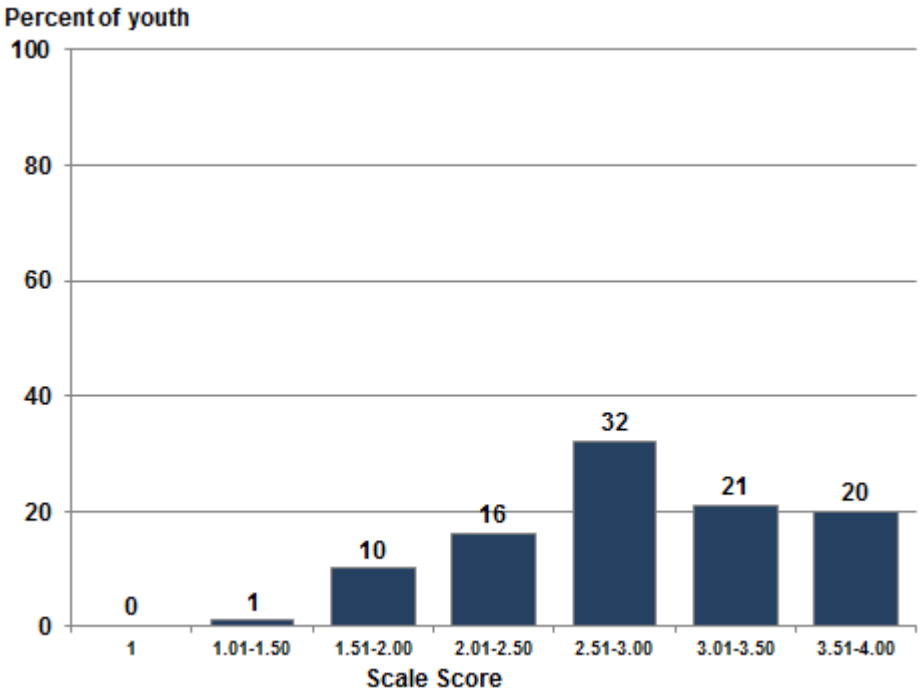
When solving a problem…

- 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	2.95	0.64	1	2.50	3.33	4



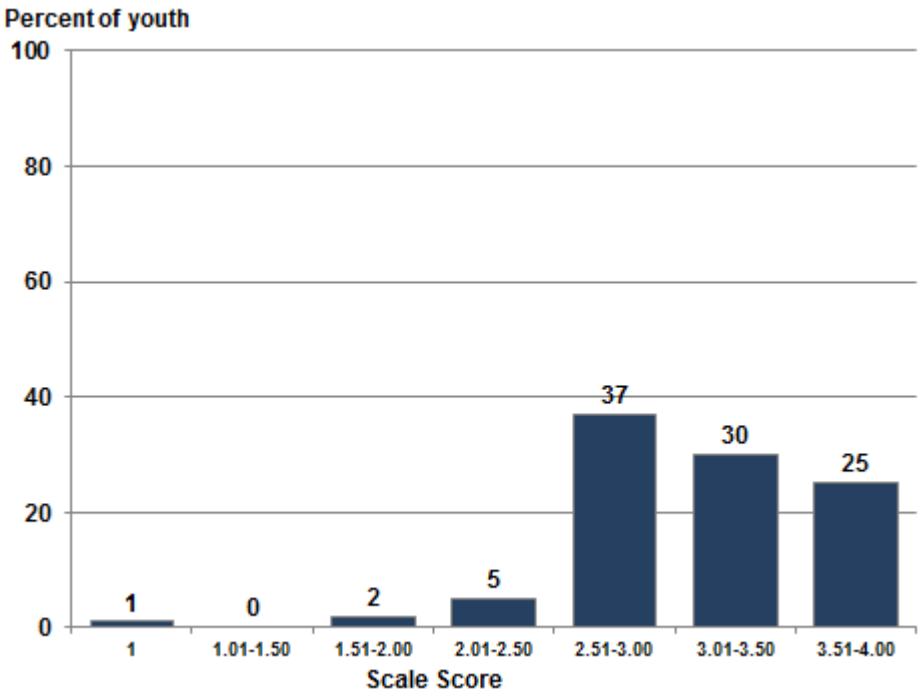
Program Benefits & Opportunities Scale

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	3.16	0.51	1	2.89	3.56	4

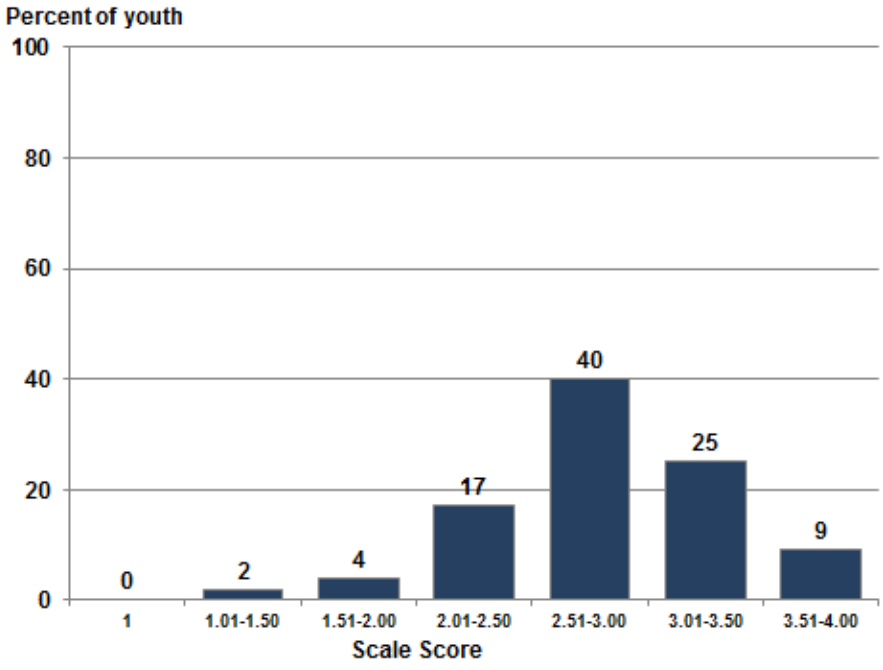


Noyce Enthusiasm Scale

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 (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	2.87	0.52	1.11	2.55	3.25	3.89



Program Climate Scale

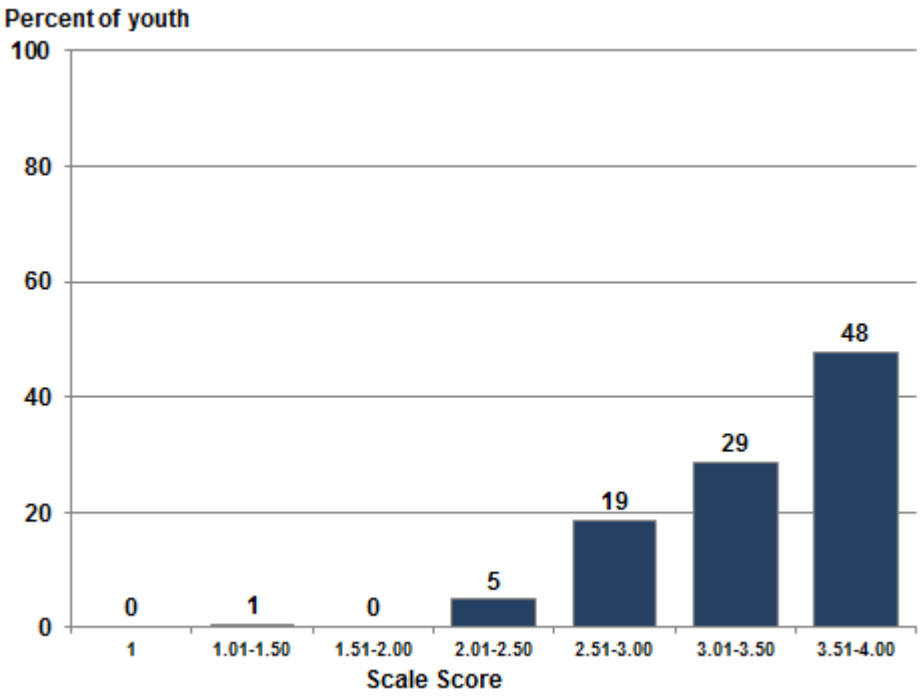
The Program Climate scale was computed to range from one to four, with four indicating that, on average, participants said the following things are always true about their program or project:

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
0.78	3.40	0.49	1.33	3.11	3.78	4

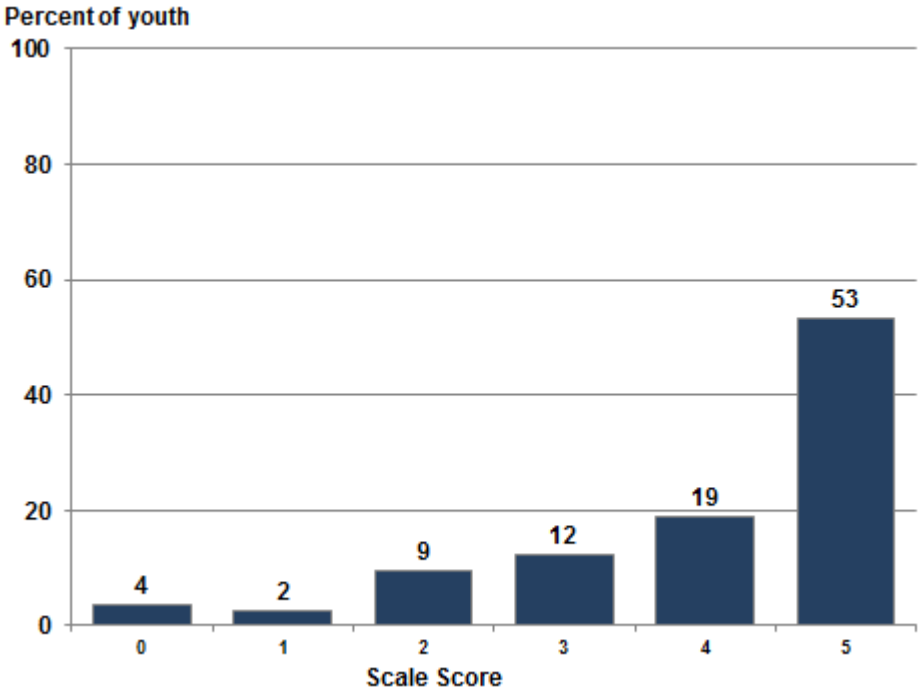


Science Process Skills Inventory, Youth Ages 9 to 12

The Science Process Skills Inventory for younger youth was computed to range from one to five, with five indicating that on average, participants said that they can do all of the following:

- I can do an experiment to answer a question.
- I can tell others how to do an experiment.
- I can write down information correctly.
- I can make a chart of picture to show information.
- I can explain why things happen in an experiment.

Alpha	Mean	Standard Deviation	Minimum	25th Percentile	75th Percentile	Maximum
0.71	4	1.36	0	3	5	5



Science Process Skills Inventory, Youth Ages 13 to 18

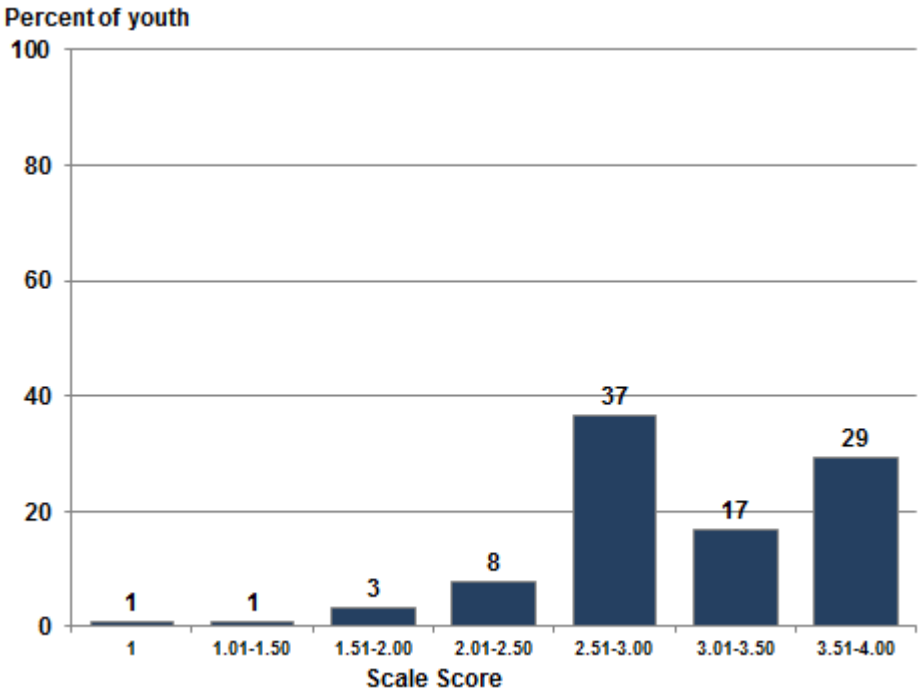
The Science Process Skills Inventory for older youth was computed to range from one to four, with four indicating that on average, participants said the following statements are always true:

- 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
0.94	3.07	0.68	1	2.73	3.57	4



Appendix C
Youth Engagement, Attitudes, and Knowledge 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

	Strongly Disagree	***Disagree***	***Agree***	***Strongly Agree***
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

21. What is the highest level of school that your mother went to? (Select ONE.)

a. Grade school
b. High school
c. College
d. Another graduate school after college
e. I don't know

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.

22a. 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.

22b. 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!