

**EVALUATION OF THE 4-H SCIENCE INITIATIVE**

**Year 2 Implementation Study**

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## Introduction

With the support of the Noyce Foundation, National 4-H Council has contracted with Policy Studies Associates (PSA) to evaluate the implementation of the 4-H Science Initiative. In 2006, the Science Initiative was introduced as a way to focus 4-H programming on teaching science, technology, engineering, and applied math content to the more than six millions youth who participate in 4-H annually. The Science Initiative aims to increase: science interest and literacy among youth, the number of youth pursuing post-secondary education in science, and the number of youth pursuing science careers.

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

As part of the effort to promote science programming, 4-H formed the National 4-H Science Leadership Team, which consists of national, state, and county-level 4-H professionals. In addition, science liaisons have been appointed at LGUs around the country to help implement programs and to recruit youth. The National 4-H Science Leadership Team created the 4-H Science Checklist as a guide for universities to use in the development of 4-H Science programs. Generally, this Checklist sets out the expectation that 4-H Science programs be inquiry-based and grounded in experiential learning, involve building science-related skills, and employ positive youth development practices.

In addition to the 4-H Science Checklist, 4-H has also developed a logic model for the Science initiative. According to the 4-H Science Logic Model, programs should be designed with the following short-term youth outcomes in mind:

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

## Findings from Year 1 of the Evaluation

The first year of the evaluation examined efforts that states have made to implement the initiative through an online survey of state leaders and science liaisons. The evaluation's first-year report on the implementation of the 4-H Science Initiative found that LGUs:

- Have developed partnerships within their university and with outside organizations to develop science programming
- Need financial and informational support to train staff and volunteers
- Are offering science programming by integrating concepts into established programming and by adapting new science-focused curricula
- Are using or planning to use some form of evaluation for the science programs they run
- Are marketing their science programs to local school districts and within their LGUs
- Frequently pointed to a lack of funds as an impediment to moving forward with science programming

During the first year, evaluators also surveyed 1,000 youth participants in 4-H science programming using the Youth Engagement Attitudes and Knowledge (YEAK) Survey developed by the 4-H Science Instrument Design Team.<sup>1</sup> The youth survey revealed that among 4-H Science participants:

- There are slightly more girls than boys; more than two thirds are white, roughly 20 percent are African American, and 10 percent are Latino/a
- Forty-one percent said that they were currently enrolled in their first year of 4-H programming and more than 60 percent were enrolled in a 4-H science program for the first time
- More than three-quarters intend to finish college or continue to get more education after college
- Most are enthusiastic about science: nearly three-quarters list science as their favorite subject and roughly half have plans to pursue a science-related career later in life
- Most feel positively about the relationships they have developed with other youth and adults in their 4-H Science program
- The majority rate the hands-on nature of their program's activities as among their top reasons for participating

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<sup>1</sup>The 4-H Instrument Design Team includes: Mary Arnold, Melissa Cater, Lisa Bouillion Diaz, Katherine Heck, Suzanne LeMenestrel, June Mead, Maureen Mulroy, Ben Silliman, Beverly Spears, and Jill Walahoski.

## Year 2 Methods

In order to understand how 4-H Science programs are being implemented, Year 2 of the evaluation has been designed to gather more detailed information about key topics: (1) state-level implementation of the Science Initiative, and (2) the process and content features of successful science programs. Instead of conducting a second administration of the implementation survey, evaluators elected to conduct in-depth interviews in a sample of states.

***Sources for this report.*** In the fall of 2010, evaluators conducted telephone interviews with state and county 4-H leaders affiliated with nine LGUs representing each extension region. During these interviews, state leaders were asked to provide details about:

- The background of science programming in their state
- Any shifts that have taken place since the introduction of the 4-H Science Mission Mandate in 2006
- The LGU's approach to managing science programming
- The strengths that 4-H as an organization brings to Science programming
- How the LGU is collecting and tracking program and participant data

Additionally, both state and county leaders were asked to provide several examples of successful 4-H Science programs, and to describe:

- The program's goals
- The program's approach to content delivery
- The partnerships that support the program
- Strategies for collecting data on participation

The appendix of this report includes a list of the state and county leaders interviewed, as well as a list of the science programs that they described.

***Further data collection plans for Year 2.*** The information gathered during interviews with state and county leaders in these nine states will be supplemented by data collected in winter 2010-11. Specifically, evaluators plan to conduct:

- In-person group interviews with identified state Science team members regarding state-level efforts to implement 4-H Science programs at the December Academy

- A national survey of 4-H Science program leaders that asks them to respond to questions about (1) the process and content features of their program and (2) enrollment in their program

Data collected during focus groups and through the program leader survey will supplement the information presented in this report in a final implementation report to be delivered in March 2011. Information about program enrollment will be used to establish the random sample of youth that will be used for administration of the YEAK survey in spring 2011.

## **Summary of Findings**

Our interviews with individuals in the nine Year 2 evaluation states revealed that localities have found both great successes and also some challenges as they have worked to develop 4-H Science programming. We learned that states that had strong science programming prior to 2006 welcomed the National Science Mission Mandate and used it as an opportunity to coalesce and strengthen their state's science programming. For those states that did not have previous experience focusing on science, further guidance and technical assistance for state leadership might support their efforts.

4-H is providing science programming through more traditional 4-H areas such as agriculture, animals, and nutrition as well as through new curricula that cover topics such as robotics, alternative fuels, and rocketry. Building the capacity of existing 4-H volunteers and staff to lead science-focused programs is a priority and states are working to develop effective models.

State and county staff are often unsure of how to use the Science Checklist in their development and assessment of science programs. LGUs may need further assistance to effectively determine which among their programs are Science Ready and should be included in national tallies of 4-H Science participants.

Some of the promising features of 4-H Science programs that states and counties highlighted include: (1) youth-centered content delivery, (2) experiential learning, (3) real-world applications of science, (4) opportunities for youth to contribute to their communities through science, (5) positive youth development strategies, and (6) a focus on moving youth through the educational pipeline toward science-related careers. These promising features will be explored further in Tier 2 of the evaluation.

## Transition to the Science Initiative

Interviews with state and county 4-H staff from nine states revealed variation in the intensity of science-focused programming prior to 2006, and shed light on the impact the Science mission mandate has had on science programming in each state. Overall, we found that the Science Initiative has prompted states with existing science programs to focus and energize their efforts, but has posed some difficulties for states that have not historically focused on science.

4-H's locally-driven programming structure is unique in its ability to adapt to the particular needs of communities. States have capitalized on this flexibility as they have worked to support science programming in their localities. In interviews, states leaders described a variety of different topics on which they have focused science programming, including, but not limited to: sustainable living, agriculture, robotics, and wind energy. These emphases often corresponded with each state's major industries and the overarching topics of interest identified in their communities.

Although states emphasized different scientific or technological topics in their science programming, states that actively supported and guided programming did so in a few common ways: they built partnerships, obtained or revised curricula, trained staff, and collected data about science programs. Overall, state leaders felt positive about the changes that have taken place since the Science Initiative began. While some states' efforts to focus on science are still nascent, all interviewees said that their LGUs are making progress toward supporting and expanding science programming.

## Impacts of the 4-H Science Initiative

Prior to 2006, the level of interest in science programming and the degree to which states focused on providing science programming differed across the nine states which provided data for this report. In one state, science programs date back to the 1980s, while in another, state leadership had just started thinking about science programming when 4-H launched the national initiative. Two states did not place an emphasis on science at all prior to 2006. Even though science was not an explicit focus in the state, there was still science-focused programming being offered in counties within these two states.

Not surprisingly, the ease with which states began to shift their programmatic focus toward science was closely related to the intensity of each state's science focus before the launch of the initiative. In six of the nine interviewed states, the state leader said that the 4-H Science Initiative provided an opportunity for them to rethink existing science programming and, in some cases, to refocus state priorities.

*The national initiative has helped us communicate that message to our faculty and our administration here at [the university], so that has been useful and helpful. The national initiative helps us know that we are on the right track. [ . . . ] We wrote our POA and used*

*that process to reflect on what we wanted to do. We teased out the priorities and the focus from that plan and put together a two-page summary that we sent out counties.*

The states who viewed the mission mandate as an opportunity to refocus their efforts in science programming have done so in different ways. In order to increase the quantity and impact of science programs, some states have increased the number of extension staff focused on science, some have tried to form partnerships to support science programming, and others have increased their efforts to publicize their science programs:

*There has been no shift in priorities, but it gave us the tools. With a small state staff and most of our county time spent on programming, we don't always have the money to communicate important messages across the state. The communications tools from the national initiative have been great and the planning for the POA helped us focus our time and attention.*

Among the states that did not focus on science prior to 2006, their state leaders said that they have worked to both incorporate new science curricula and to consider how science can be infused into existing programs.

## **State-Level Management of 4-H Science**

The roles that state-level extension offices play in implementing 4-H science programs vary: some offices play an active role in overseeing and supporting 4-H science programming, while others are less involved. Within their extension offices, most LGUs relied on either a committee or individual charged with providing guidance for 4-H Science activities.

***Science-focused state committees.*** Before 2006, two states already had specific groups that were dedicated to guiding science-related programming in place. A state leader at an LGU that has a history of focusing on science explained:

*In the early nineties we had a group called the science and tech work team which is now the SET program work team. It is comprised of faculty and outreach staff, a few with extension appointments. There are also 4-H educators from different areas of the state who are involved.*

Several other states formed science committees after 2006, which usually consist of a combination of LGU faculty, extension agents, and industry professionals. A leader from a state that has only focused on science since the advent of the initiative remarked:

*We have a leadership team comprised of specialists and LGU staff. The leadership team adopted the National 4-H Council logic model which outlines the goals of the SET initiative, including the change in attitudes toward science, using processes in daily life, and moving toward more graduates in natural science/engineering fields. [. . .] We want to identify and provide materials that make the science explicit in the programming.*

***Leadership from key individuals.*** In addition to leadership teams, two states have looked to key individuals to guide science programming. One of these states hired someone with an engineering background as its science specialist, which, along with the scientific background of other staff, has enabled the state to demonstrate to potential partners that they are focused on implementing science programming. In this state, the leaders help facilitate training for staff, conduct presentations, and have helped secure resources for programs. The other state has two state leaders with differing responsibilities: one works strictly with physical science and robotics while the other works with life sciences.

***Local-level guidance.*** One state has taken a more decentralized approach: a group of extension educators fulfill science leadership obligations usually given to one individual. Programming decisions are then made at the county level. The state-level interviewee explained:

*We have not organized committees. In a county, they might have an advisory group that works with [science]. But for the most part, we don't have that kind of a support group in terms of implementation. It's more the emphasis of individual educators, or working with a few staff in getting something going.*

The various management structures that states have put into place have allowed states to individualize their efforts to scaffold science programming. Most states have found success by relying on centralized leadership to set priorities and implement new efforts. The sole state that did not take a centralized approach is also one that has made only modest gains in its implementation of science programming. While the decentralized approach may not necessarily be limiting the growth of science programming in that state, it may be that having a unified voice might help the state prioritize science programming.

## **Partnerships**

Many interviewees said that partnerships with external organizations and with departments within their LGUs allow state and county staff to strengthen science programming in their localities. Partnerships support 4-H science programming in a number of ways: first, by providing volunteers who are content experts, second, by providing youth with examples of the real-world applications of the science they are learning, and third, by providing capital and in-kind contributions.

***Land grant universities.*** State and county interviewees highlighted the value of establishing relationships between science programming and the land grant university system. Access to university faculty and students who specialize in science, technology, and applied math has been an asset on which 4-H has been able to capitalize. One state leader noted the benefit of partnering with their LGU: “With our connection to our land grant university, it’s been a tremendous asset to be able to call upon the knowledge of colleagues.”

In addition to having access to content knowledge experts, partnerships with university departments has translated into a variety of program opportunities for youth, including career and education exploration activities that help youth see pathways for pursuing science.

One state that had not previously worked with the science departments in their land grant university said that they were starting to make inroads in this area. The state leader explained that they are collaborating with the LGU's school of engineering to develop a program that will focus on teaching girls not only about engineering content, but also about higher education and the importance of pursuing a post-secondary degree.

Another LGU hosts two summer college access programs on campus that serve roughly 500 students every year. One program is for first and second year high school students and focuses on introducing college life and the college application process. The other is for rising juniors and seniors and focuses on giving them a chance to explore an academic department of their choice by spending time with students and faculty. The program's key goals are to help participants learn more about the steps they must take to get into college but also to think more about the areas that they may be interested in studying.

*They come to campus and spend three days in a dorm, spend time with their departments and then attend keynote and a capstone. From the experience, hopefully they are inspired to seek more information about attending the university or exploring the academic subject that they focused on. Or, they might find that even though they thought they were interested in a particular department, at the end of the program, they realize that is really not what they want to do. That is a good outcome, too.*

**Outside organizations and individuals.** State and county interviewees reported that they have worked with both businesses and individuals that support 4-H Science programming. Some LGUs' partnerships with businesses have involved science content experts volunteering at 4-H programs, while others involve donations of money to develop or support programming. One interviewee explained that their state has used a partnership with Time Warner Cable to produce public service announcements about 4-H programming that the company then aired on their networks. Another state highlighted funding that they have received from local industry:

*Exxon provided six \$500 mini grants to counties so that we were able to support them in doing training and resources. The Chevron USA corporation sponsored our 4-H agents professional meeting for \$10,000 this past summer where we focused on SET, and from that grant, we were able to provide each of the 12 districts with \$500 to provide a science, engineering, and technology training.*

In addition to partnering with science-focused groups, some states mentioned networking with other organizations that work in informal education or science education. One state talked about the benefits of partnering with an organization that specializes in coordinating different efforts among the state's out-of-school-time programs. The interviewee said that participating in this network: "provides coordination, research, and support for after-school programs. They publicize SET development networks. It's a mutual relationship of information sharing."

There are a wide variety of potential partners that can help LGUs enhance and support their science programming. Whether it is working with someone within their university, reaching out to a potential funder, or partnering with organizations that specialize in informal learning, states would benefit from sharing lessons learned about how to develop relationships that support science programs.

## **Approaches to Science Content Delivery**

As they worked to bring a greater focus on science programming, states have taken two general approaches: adapting existing 4-H programs to include more science, or starting new programs by adopting new science-focused curricula.

***Using new science and technology curricula.*** Interviewees reported using curricula that focus explicitly on science or technology topics, such as wind energy or robotics. State and county interviewees formed new clubs or programs centered around these curricula, and also deployed these curricula into established clubs or school-based programs. Some of these curricula were developed by 4-H, such as Junior Master Gardener, Power of Wind, and certain robotics curricula, while others were developed by outside organizations.

Overall, states and counties reported that they have been more successful starting up new 4-H Science programs than incorporating science elements into existing programs. In particular, interviewees said that technology clubs and the various robotics curricula (such as NXT, Gear 21, and First Lego League) have been successful at generating youth interest. One state leader explained:

*It is a moving target for different ages, but rocketry, those things are something that everyone can enjoy, and that anybody can teach with. This Power of Wind, with kids' wind model turbines, they have been a huge success. When I take those out, I can keep a class of 30 third-graders engaged for 45 minutes. We teach the hands-on experience and provide manipulatives that all kids can enjoy. It is not going to be for everyone, but at least we are able to put it out there and take those smaller numbers of kids that might want to find out more, and start working with them on independent discovery.*

***Incorporating science into existing 4-H programs.*** State and county leaders said that they have worked to modify existing curricula and project books in order to emphasize scientific skills and processes such as observation, inquiry, and experimentation. Interviewees largely agreed that many of the topics covered in 4-H programming are simply real-life applications of scientific content and scientific inquiry. While interviewees commented that science content or inquiry may be embedded in the content of many programs, it takes time and effort to make these concepts a key focus of the curricula. One interviewee explained:

*One of our goals is to move to the animal science programs and implement a more inquiry-based process into the activities, but we haven't a chance to do it. [...] We want*

*to move more in the explicit science content areas. In the future, we are going to bring this to the established programs.*

Another state leader said:

*We're also looking to try to implement the SET abilities vocabulary into our 4-H project work. We are trying to get the county agent to the point where they are beginning to look at the everyday projects we are doing and bringing in the terminology from the SET abilities when we are teaching the kids, such as during livestock judging. When they are looking at an animal, [the staff] should be asking kids to speak in terms of classifying and ordering. In everything we do, there is a tremendous amount of observing that goes on. We're trying to push that.*

A county leader reported that they experienced difficulty in carrying out the task of incorporating science inquiry into clubs' current activities, because "you're asking them to reset what they do." Most club leaders, other volunteers, and 4-H staff need guidance from curricula or training in order to be able to incorporate science into existing programming. As one state leader described:

*Our subcommittee on food is really pushing hard to get more science into the curriculum. They say they don't know how, and they are asking us for help. So we are trying to come up with some best practices to incorporate science into the series. It is slow, because we can't revise the whole series at once. The food side of it is in a whole other college [within the university], the College of Human Ecology. They have their own discipline, their own reasons for coming to the table. These are extension employees; we're not paying them. It is taking some time. [Incorporating science] has been embraced, slowly.*

While bringing in new science curricula has been an effective way to implement the initiative, helping staff and volunteers bring science content and process skills into existing 4-H programming will be crucial to the success of the Mission Mandate. Because revising existing curricula and project books to incorporate science can be time consuming and challenging for states, national guidance on curriculum adaptation could help reduce the burden on localities.

## **Staff and Volunteer Capacity**

State and county interviewees expressed a great interest in supporting their staff and volunteers in order to provide high-quality science programming. Interviewees said that many volunteers and staff have trepidations about teaching science process skills and science content. In order to support staff, many states have focused on providing various types of professional development, and some have also focused on preparing activity kits or utilizing content experts.

***Making science accessible.*** Leading science programs requires that staff and volunteers not only have youth development skills, but also familiarity with science content and effective

pedagogy. Several county-level leaders have noticed that volunteers are often uncomfortable with science projects due to their lack of science expertise. One interviewee explained:

*Volunteers still need training. We get scared of science because we feel that we weren't good at it in school. We don't want to be the ones who take that on a science project for kids if we weren't good [at science].*

Most interviewees reported that localities are working to provide training for staff and volunteers that focuses on getting them comfortable with the subjects they will be covering in their 4-H projects, clubs, and after-school programs. One interviewee explained, “one of the things that I've asked [state staff] to do is to make it ‘Science for Dummies’ and make it so easy that [county staff] can't say no.” A leader from another state said:

*In terms of achievements, we've accomplished quite a bit in the realm of professional development. We've had workshops and training events for different audiences. In February, we hosted volunteers and community partners for an adult leaders' forum. A lot of these events take place yearly. We have had a concentrated effort to implement SET workshops since the start of the initiative.*

One LGU trained its staff and volunteers to deliver a fuel cell car activity by having them assemble the car themselves. Under the direction of the training facilitator, staff members completed the activity as though they were youth participants and received support when they were unsure of how to approach the assignment. One county leader explained, “[The training] was good because I knew what I was doing, and it made it easier to answer questions...It was great that we could actually go through the activity.”

***Encouraging leaders to focus on science embedded in program content.*** In order to help 4-H staff and volunteers to deliver science content, some interviewees said that they have tried to emphasize the fact that there are many latent science concepts in 4-H programs. One state leader reported:

*We stress the importance of science in livestock projects. We are slowly getting there, but it is taking some time to get our volunteers to realize its importance. They are concerned with looking good for show, but the point I'm trying to bring home is, [the need for] good balanced nutrition [for the animal] in the meantime, that's science right there. Hopefully as we progress along we can start to get volunteers more focused on science.*

***Prepared instructional kits.*** State and county agents support programs by delivering materials and resources necessary to complete science activities, especially by assembling activity kits. In addition to supporting volunteers leading out-of-school science programming, 4-H agents also work with school-day teachers in 4-H science school enrichment programs. In one state, the authors of the project books trained teachers on all aspects of the particular curriculum in order to enable them to teach the material on their own. An interviewee from another state

talked about how 4-H works to provide school-day teachers with the materials that they need to implement 4-H Science activities:

*The school enrichment coordinator will look into what activities s/he wants to do, and makes sure that the teachers get the materials that they need. She can bring them fully packaged enrichment kits that they can pick it up and make sure that they have what they need without worrying about the finances and having to go out to get materials.*

***Using content experts to help deliver programming.*** Sometimes, a 4-H program may have access to volunteers with expertise in the subject matter. While these science content experts may have minimal experience working with youth, interviewees said that 4-H works to help these experts strike a balance between teaching program content while encouraging positive youth development. One county leader said that she is recruiting content-expert volunteers, training them in 4-H instructional methods, assisting them with recruiting youth, and helping them secure resources for their programs.

*This year we are starting a technology club. What it looks like remains to be seen, but we have two volunteers, one is a mathematician and one is an engineer. They are working with the kids to help them decide what area of technology they want to go forth in.*

Because supporting volunteer and staff capabilities is an on-going challenge, states and counties have worked to develop a number of techniques to support program leaders as they teach science process skills and science content. Supporting states' professional development efforts and giving states the opportunity to share their experiences may help 4-H identify and disseminate best practices that will not only guide this organization but the field, as well.

## **Data Collection and Evaluation**

States are required to monitor enrollment in their science programs, since one of the goals of the 4-H Science Mission Mandate is to use science programming to draw new youth into 4-H. Measuring youth enrollment and participation levels in these programs can also produce useful information for program evaluation. States are currently using several different tools to collect and analyze youth enrollment and participation data, including ES 237 (4-H's mandated federal report), Blue Ribbon, Access 4-H, and 4-H Online.

***Defining 4-H Science programs.*** Collecting enrollment and participation data for science programs can pose challenges for a number of reasons, not the least of which is the difficulty that states and counties reported having in determining which of their programs qualify as 4-H Science. States and counties need to be able to clearly identify their science programs in order to track youth enrollment, but interviews with state and county staff illustrated that the distinction between science and non-science 4-H programming can be unclear.

State interviewees expressed some confusion about how to use the Science Checklist to determine whether a program qualifies as Science Ready. Respondents had a difficult time

understanding whether to take the Checklist literally in order to determine which of their programs would qualify as Science Ready.

*There are various definitions, and I don't think we pinpointed a definition to determine which programs qualify as science [. . .]. We are still trying to figure out a definition for new science and technology and what falls under that heading.*

Another state has not yet dealt with the question of which of its existing programs qualify as science, because they have been focused on adopting new programs that have a strong scientific focus:

*We do not have a hard clear line for Science or Science Ready. [. . .] We have strictly focused on science and engineering content and have not really worked with the existing world of 4-H. All of our partners have been engineering and science partners and we stay with that focus.*

**Challenge of categorizing traditional 4-H curricula.** When state and county staff must determine which of their programs qualify as Science Ready, traditional content areas can present a challenge. Programs such as nutrition and various agricultural programs have underlying science elements but may not explicitly teach science skills. One interviewee explained:

*I'm thinking about animal science programs that emphasize the care for the sheep and taking them to the fair. There isn't an emphasis on acquiring science skills. We go back to the National SET checklist. However, there are a few projects that blur the line that raise conversations among the leadership team to check the items on the Checklist. Some of the Checklist items are required, some are not. So we need to think.*

Another interviewee said:

*At some point, all of our projects have some SET component to them. Food and nutrition should be the biggest science program that we have, but our context for that is more human health-related than the science behind it. But everything we know about human health comes from science! So if we go through and dissect [programs], everything would fall under science.*

**Creating individualized rubrics.** Instead of using the Checklist, some states said that they have developed their own approaches to interpreting what qualifies as Science Ready. Two states used the Science Checklist to craft their own tools to identify science elements within programs. Science inquiry and experimentation are still key parts of each state's revised checklist, as one state leader explained:

*We adapted a modified version of the checklist. We included experiential and inquiry based learning. I think the two that come out are the experiential inquiry and providing*

*opportunities to improve science ability. Everything that we do at 4-H is supposed to encourage positive youth development.*

Another state leader explained:

*We developed something that talks about what makes something a good science activity. We wanted to include the Checklist as part of that, but it was too long, so we modified it slightly. [. . .] The pages of SET Checklist are too thick, and I feel like I do not have the time to devote to make sure all of that is incorporated into what we do.*

A leader in another state said:

*We developed something that talks about what makes something a good science activity, a one-pager that has a checklist of things that you can include. We developed a curriculum called the 4-H science toolkit, it has six activities in nine content areas.*

***Collecting consistent and complete data.*** Besides the difficulty in defining programs as science programs, state and county leaders identified some challenges related to data collection and reporting. The first challenge staff reported was that of collecting consistent data from programs. One state leader explained that some leaders report participation every time the club meets, while other leaders report participation more sporadically. Another leader said that it is difficult to get leaders to be consistent with their reporting.

County leaders reported that collecting data for school enrichment program participants poses a unique challenge. In school enrichment, 4-H staff must rely on a group enrollment tally in which they estimate the group's demographic composition but do not individually track youth. Since the names of these students are not recorded by 4-H staff, it is impossible to track these youth over time. If a student in a school enrichment program participates in the program for more than one year or joins a 4-H club, current data collection methods cannot track that student through all of these 4-H activities.

***Entering and using data efficiently.*** The second data collection challenge that respondents mentioned was the lack of staff or volunteer time to enter and analyze data. The amount of manpower necessary to enter participation data is a burden for counties; one county leader said that her staff collect data but cannot analyze it because of time constraints.

Several county leaders noted that the databases themselves can pose challenges. One county leader explained that in the past, youth were classified according to the particular 4-H curricula they were using in their project. However, the new database classifies projects by topic area rather than a specific curriculum. In practice, it is difficult to classify some projects under one topic area, such as a paper-making and basket weaving project conducted by one county leader: "There was no way to report that. [. . .] What I really did is lost." Another county leader reported trouble piloting the new ACCESS 4-H enrollment system, saying that, "I can print out a list of kids for a program and then print it again and get a different set of kids." However, a

different county leader was pleased with ACCESS 4-H because it finally allowed the county to track participation data and avoid duplicating paperwork for returning participants.

In order to help 4-H achieve its goal of reaching one million new youth through science programming, states need to be able to accurately tally participants. Interviewees expressed some concerns about how to accurately determine which of their state's programs qualify as 4-H Science. Further, they expressed some misgivings about their own ability to record and analyze program participation. Giving states further guidance on how to use the Science Checklist to and how to efficiently manage their participation data demands will help 4-H progress toward the goal of counting new 4-H Science participants.

## Features of 4-H Science Programming

During interviews, we asked state and county staff to describe a few promising science programs that are currently offered in their localities. In this section, we describe some of the program features that state and county staff highlighted in these interviews. In many cases, the programming features they described aligned with the best practices outlined in current research on informal science learning.

### Youth-centered Content Delivery

In traditional school-based science learning environments, rote learning often takes precedent over inquiry and exploration as teachers react to the demands of assessments that prioritize memorization (President's Council of Advisors on Science and Technology, 2010). Increasingly, the value of science teaching that places young people on the "receiving end" of information is being called into question. While schools and teachers must be responsive to the standards placed on them, out-of-school-time science learning presents youth with an opportunity to learn scientific content in a more engaging and interactive manner.

In fact, research has shown that informal learning opportunities which allow youth to make meaningful choices about what they do and how they do it can help youth achieve desired outcomes. Programs that allow youth to contribute to their experience can help participants to develop increased interest and engagement in science, improved understanding of science contexts, increased self-confidence and feelings of competence in science, and self-reported improvements in academic achievement (Institute for Learning Innovation, 2007).

Across the majority of LGUs in this study, state and county agents reported employing a variety of programming approaches that encourage youth to help direct their own learning. One interviewee explained that 4-H Science programs are successful because they are flexible enough that youth can pursue their own interests within the program's content area:

*As opposed to a school, we don't insist that everyone learn every aspect of it. If what really cranks your passion is computer programming, by all means. We need those skills and we'll put them to use here. If you don't really like building we're not going to make you do that. We have the flexibility to tap into what sparks kids' passion. You get better results by letting kids direct themselves and have a voice and a choice.*

A county interviewee explained:

*Because we work in an informal setting, we have more opportunities to involve students in things they are interested in. They were interested in air quality and we could pursue that with them. That distinguishes [what we do] from formal learning. We find out what youth are interested in. [. . .] We have the opportunity to customize, or build the program and delve into the activities that the kids are interested in.*

At a technology club in one county, youth are encouraged to pick the areas of technology that they are most interested in studying, and then those areas become the focus of the club's activities. The county agent explained:

*The main goal is really being youth-led. The volunteers' intent is for the youth to come up with a list of priorities, in terms of technology, what pieces of technology are they most interested in and want to learn more about.*

One of 4-H's strengths as an organization is that many of its programs encourage youth to pursue the topics that interest them most. When youth opinions and interests are understood to be important tools for planning and directing activities, youth may be more likely to stay engaged and involved in science programs.

## **Experiential Learning**

A growing body of research points to evidence that experiential, hands-on learning is an effective approach to teaching science content. A research synthesis developed by the Education Development Center's Inquiry Synthesis Project demonstrated that increased opportunities for active engagement are associated with student learning gains; of the studies reviewed, five of six found statistically significant improvements in student conceptual learning from instruction with hands-on components, particularly when paired with instructor-guided discussion (Minner, Levy, and Century, 2010).

Many of the 4-H science programs that state and county staff described provide experiential learning opportunities through activity kits that cover a range of curricula and support hands-on learning. State and county program leaders overwhelmingly agreed that a hands-on approach is a way to empower youth to take ownership of their learning. A county agent explained:

*The greatest strength of 4-H Science programming is the hands-on learning approach, where youth actually get to do it. Secondly, our youth-adult partnerships, where our adults really are empowering youth to learn on their own and be a little more self-directed. The whole thing, particularly with science, you do trial and error, and how do you reflect back on that? Our whole model of "reflect and apply", and youth-adult partnership, that is more of an empowering role than a teacher, where it's "watch what I do, and then you do it." It is more, "you do it, and I'll be the guide on the side."*

Another county interviewee said:

*Our big thing is hands-on learning, have kids get dirty and not get graded. The pressure to get it right the first time is gone; the beauty is that they don't have to get it right the first time. Kids think, "I can do it with my friends and have fun." They don't recognize they are learning anything until they go home and process.*

Another interviewee explained how during a rocket building activity, 4-H staff helped a struggling student become excited about an engineering question and use scientific inquiry to solve a problem:

*We had one student, we were constructing rockets. The student asked me, “I’d like to put two bottles together instead of one. What do you think would happen?” and I used experiential learning, and I led him through. The teacher listened, and afterwards told me that the kid was the worst in the class, maybe the worst in the school. And here he is talking like a scientist. There was a whole new dynamic that developed between that teacher and that student. When would that have happened in a traditional classroom?*

In virtually every interview we conducted, state and county staff said that one of 4-H’s biggest strengths is its focus on giving youth the opportunity to do hands-on activities. Because this content delivery strategy has been proven effective in engaging and educating youth, if 4-H can continue to focus on this strength, it has the potential to have widespread impact on science learning.

## **Real-world Applications**

In addition to experiential learning, providing youth with examples of how science functions in their daily lives is also seen as an effective method of engaging science learners. A recent report from the National Science Foundation (NSF), recommended that K-12 education borrow from informal education’s focus on linking content to its real-world applications (NSF, 2010).

***Sparking youth interest.*** Interviewees said that when the content of activities is clearly connected to youth’s experiences in their own communities, they are more likely to become engaged in the learning experience. One county interviewee said:

*For the food science program, youth are learning about the impact of the science and how it’s used to get foods from one place to the other. [. . .] 4-H Science gives that “gee whiz” factor and we provide that opportunity to see the application in the real world.*

Interviewees said that by teaching science process and content through activities that focus on everyday phenomena in youth’s lives, leaders are able to successfully engage youth who might otherwise not be interested in science. For those youth who may have little interest in school-day science classes, participating activities that are not explicitly science-related can be an effective method of sparking their interest in science. A county interviewee explained:

*Kids are doing things that they don't necessarily recognize as science. They don't do it because it is science, they do it because it is fun. It's only later they connect the dots. It is that back door approach that works so well, rather than saying, “here, come join the science club.”*

One county agent surmised that when participants see how the science applies to something tangible in their lives, they tend to retain what they have learned and understand its importance:

*The students get the visual of what's happening that you don't get from learning through a text book. Having a field staff has made this easier. I took fourth grade classes to do a model of a watershed to see how water and sewage treatment plants work. It really makes the science come alive. One of my students came up to me and said that she had never thought about what was in her drinking water before. When you get an impact like that, it's incredible.*

**Emphasizing science in topics that already draw youth to 4-H.** Scientific concepts are already embedded in the content of many 4-H programs. One county leader explained how their animal programs show youth the direct application of science concepts:

*Science is so embedded in everything we do in animals, from animal health to animal behavior, which is primary in our clubs whether you're showing your guinea pig, or you're selling your steer for food. How do we keep animals disease free? Why does the quality of the water relate to the health of the animal? An understanding of behavioral science as it relates to that animal is incredibly important. Asking questions like: why does a horse lay its ears back and what are they telling you?*

Another county interviewee explained that they have worked to underscore the science focus in their pre-existing animal science programs:

*National Council doesn't always look at animal science programs as Science. Our animal care training is very much science focused, it's the science of health and nutrition for the animal. We package kits around animal science.*

**Developing citizen scientists.** In keeping with 4-H's goal of building community-minded youth, many science programs work to show youth how science can be used to improve their communities. As one interviewee explained, "We talk about the technology first and, as we do that, we look for real world applications of that technology, especially things that the kids can do to benefit the community." For example, youth have used GPS/GIS mapping to improve nature paths, and to examine the impact of pollution on watershed areas.

One county interviewee in Delaware explained how she modeled a project on water pollution on the natural water systems in the state to help youth see the connection to their lives:

*Last year I thought it would be important for them to know about pollution of the water system since Delaware is a coastal state. We did a mini oil spill and the kids had to use different types of tools to clean up the spill. This opens questions for them. We brainstormed about what worked and what didn't, and talked about what we need to be doing. They learn that we need to be good conservationists and be more green, and do things that protect our environment. This brings in other elements like the Coast Guard*

*and the people who work in our waterways, the companies that transport the oil, and the wildlife that is affected. There's always a take-home for them.*

Another interviewee talked about a club project that not only involved hands-on learning and scientific inquiry, but also an opportunity to share what they learned with the local community:

*You want to make it real. I'd like to have it come full circle. Some kids last year were doing a bird box survey with us. Their inquiry question was "which way should the hole face?" The kids set up a research project to answer the question. They did an experiment and collected data. They shared their information in the community. They hosted a public event and talked at the local Watershed Council and the Wetlands Conservancy. They're increasing the knowledge of their local community. They're citizens, just shorter. There is no height requirement to be a citizen. So how do you provide those opportunities for them to participate in the public domain?*

Many 4-H programs are grounded in topics that youth experience in their everyday lives. When youth interest has been sparked because they understand the real-world applications of what they have learned, youth may use what they have learned to make positive changes in their communities.

## **Positive Youth Development**

4-H programs put a premium on helping youth develop into productive and caring individuals. State and county leaders' descriptions of 4-H science programming revealed not only a focus on science content, but also an emphasis on encouraging positive youth development.

***Relationships and interpersonal skills.*** Many 4-H Science programs that interviewees described are structured to encourage youth to work with one another under the guidance of a supportive adult or near-peer mentor. By working together to solve problems, youth develop interpersonal and teamwork skills as they master scientific content. One interviewee described a robotics club, saying:

*We wanted them to have team building experience. They are 3 or 4 to a group to work on the robots. It helps them see everyone is important and has different skills. I see it as a wonderful way to bring the quiet child out because they must be a part of the team.*

Another interviewee said that it is important for youth to be able to develop friendships with others who have similar interests in the science content area:

*We build relationships with them and they look forward to [coming to the club]. Relationship building and the sense that they are being a part of something are really important. They are building relationships and making friends. This program gives them an opportunity to do something with people with [the] same interest.*

Another interviewee explained that an important piece of a successful 4-H program is an adult who is able to develop positive relationships through the learning experience:

*I would say that the strengths that 4-H has is that it brings a group of youth together with an adult who teaches the content area but also helps to develop relationships. What I hear from parents is that the program teaches kids how to get along, public speaking, and skills that help them to become productive citizens.*

**Youth leadership.** Beyond developing positive relationships and interpersonal skills, some interviewees said that 4-H science programming encourages youth to take on leadership roles. Research has shown that offering youth leadership opportunities in out-of-school-time programs is positively associated with high levels of youth participation (Russell, LaFleur, Palmiter, Low & Reisner, 2010). One interviewee described a school-based club where youth leadership is an essential part of the curriculum:

*[The program] is a school Project Club. Once a month they have a meeting where youth actually lead the meeting and use that meeting to guide the program. We are going to have them learn leadership, and we've got the officers elected, it changes the whole dynamic of the program when you have six kids that are officers.*

Interviewees also described 4-H Science programs that engaged older youth by asking them to design and lead activities for younger participants. One county leader described how youth are prepared to lead camp activities:

*For the day camps, our counselors are 14 to 19. We start training them in January. They meet once a month from January to June. They are trained in youth development and behavior management, and we did a lot on classes. They get to focus on planning out their curriculum and doing different activities in that curriculum, so they know what to do. I also work on our statewide residential camp. For that we hire college-age youth 18 to 24 years old. We also do a training weekend, and we start planning those camp classes in February. They'll look through a curriculum and decide what to teach, and I'll work with them to decide what to do, to make sure it is really educational and hitting all the points.*

## **Connecting Programming to the Education Pipeline**

**Reinforcing school-day learning.** Many 4-H Science programs, from school enrichment programs to clubs, work to reflect their state's priorities for science learning in their curricula. Because 4-H has a strong connection to schools in many states, a number of interviewees said that they have used school enrichment as the primary drivers of science programming. In one state, connecting science curricula to state education standards is possible because state leaders have worked to develop strong relationships with state-level education groups:

*Whatever the schools in [city] say they need from me, I say, how can I help? What is it that you need, and let's see if the resources of extension can serve those needs.*

Another interviewee commented:

*I think the 4-H Science activities are tied closely to education standards compared to other 4-H activities. There's a strong effort to link our curriculum to the school curricula. We have a strong relationship with the in-school program. We work with about 2,500 school students during in-school programs. There's a direct connection to the academic contents standards.*

Previous research on informal education has focused on the impact of after-school programs on student academic performance, most notably for students in programs that work closely with school staff to align their programming with content delivered during the school day (Afterschool Alliance, 2010). Collaboration with teachers and districts allows informal science programs to support academic success by reinforcing concepts learned during the school day and by integrating science content with other academic areas (Peterson and Fix, 2007). By incorporating state science education priorities into 4-H learning opportunities, state and county leaders say that they are able to reinforce the learning happening in local classrooms.

*If you want to change behavior of [4-H staff and volunteers], if there is not money behind it, and no promotion behind it, how do you motivate people to do science? Having said all that, our greatest success with school enrichment was because it makes sense. That is the reason people have jumped on board. The national standards are aligned with the 4-H Science curriculum. And the school enrichment programs are bringing new kids into 4-H. And if you are evaluated based on how many kids you bring in, everyone wins.*

*They might not recognize it here [in the 4-H program], but when they go to their classrooms and start talking about ecosystems, they have some direct experience they can draw on upon to understand that.*

Furthermore, by using inquiry and real-world applications of science, 4-H programs can help youth see the real-world application of what they learn in school:

*We're using inquiry; it's a state and national benchmark. K-12 schools are required to have a science inquiry plan.*

***Moving youth through the science education pipeline.*** Current research suggests that introducing youth to science careers early on is an important way of encouraging youth to pursue science in secondary school and beyond (Tai, 2006). Youth, especially those from groups that are underrepresented in the science fields, can benefit from learning about the various careers that require scientific knowledge; seeing examples of people like them working in science; technology, engineering, and applied math careers; and learning about the educational steps they must take to pursue science-related careers.

While many interviewees did not specifically mention increasing the numbers of underrepresented youth in science fields, there were three LGUs that did discuss their efforts in this area. Through partnerships within the university, with school districts, and with external organizations, interviewees from these LGUs said that an important focus of their work is encouraging youth from populations underrepresented in the science fields to pursue science in school and then in a career.

One interviewee described a mentoring program that pairs youth from underrepresented minority groups with adult mentors in science-focused industries; the partnership seeks to increase youth interest in scientific fields and to leverage this interest to encourage youth to attend college. The interviewee explained that youth who are not familiar with science-related careers and who do not know what educational choices they must make to pursue a science-related career need more help to get on the right path:

*One thing that we've found about career fairs and college fairs is that they're great for college-oriented kids. For those that have not navigated the system, they need a lot more support. You have to build a program that gets them to the door. A big goal is college admission. We want to get them interested in science to get them on the trajectory toward college.*

In another state, the extension office has designed a program focused on increasing the number of young women interested in pursuing engineering:

*The program puts a focus on women in science. The goal is to show all youth that women can have successful careers in science, that it is not unusual to see a woman as chemical engineer. To break that stereotype that women don't have careers in science.*

In order to inspire more youth to pursue science through their educational and professional careers, it is essential for them to participate in programs that provide a point-of-entry into the science fields. 4-H should continue to develop programs that connect informal science learning to educational and career pathways in science.

## Conclusions and Recommendations

From our conversations with state- and county-level 4-H staff, we learned about states' current efforts to implement the Science Initiative as well as their flagship science programs. Based on these interviews, we conclude and recommend the following:

- The Science Initiative prompted states with existing science programs to focus and energize their efforts, but posed difficulties for states that had not historically focused on science. For those states that did not have previous experience focusing on science programming, further guidance and technical assistance may support their transition.
- States are using a range of approaches to manage the science focus in their states. While evaluators did not determine that one management method was most efficient, states that are struggling to roll out their science programming may need assistance finding more effective leadership models.
- Land grant universities' academic departments and outside organizations can provide resources that support successful science programming. States may need assistance learning how to leverage partnerships to develop and enhance science programs.
- 4-H has the potential to build youth's science skills through new science and technology programming as well as through more traditional 4-H areas such as agriculture, animals, and nutrition. Because revising existing programming can be time consuming and challenging, national guidance on curriculum adaptation could help reduce the burden on states.
- While states are developing trainings to provide their staff and volunteers with the tools to lead science programs, they would benefit from national guidance and further support for their efforts.
- There is confusion among states about how to use the Science Checklist and many state leaders expressed a desire for a more structured rubric to evaluate their science programs. If the Science Checklist is intended to give states general guidance for the development of science programs, state leaders may need further assistance to effectively determine which among their programs are Science Ready.
- Some of the promising features of 4-H Science programs that states and counties highlighted include: (1) youth-centered content delivery, (2) experiential learning, (3) real-world applications of science, (4) opportunities for youth to contribute to their communities through science, (5) positive youth development strategies, and (6) a focus on moving youth through the educational pipeline toward science-related careers.

These findings from interviews with state and county 4-H staff represent the first wave of data for the Year 2 implementation study. The final Year 2 implementation evaluation report will supplement these data with findings from a survey of 4-H Science program leaders, as well as focus groups with state science leadership at the December Academy.

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## Appendix

### Year 2 Interim Report Data Sources: State and County Interviewees

State	State Contact	County Contacts	Programs
California	Steven Worker	Marianne Bird Sandy Sathrum	<ul style="list-style-type: none"> <li>• On the Wild Side</li> <li>• Science Wizards</li> <li>• 4-H2O</li> </ul>
Texas	Matt Tarpley	Sheryl Nolen Richard Parrish	<ul style="list-style-type: none"> <li>• Ready SET Go</li> <li>• Water</li> <li>• Life Cycles</li> <li>• Power of Wind</li> <li>• Science in Agriculture</li> </ul>
New York	Celeste Carmichael	Nancy Caswell	<ul style="list-style-type: none"> <li>• National Science Day Experiment</li> <li>• Gardening</li> <li>• 4-H Career Exploration</li> </ul>
Ohio	Bob Horton	Jackie Krieger Patty House Nate Arnett	<ul style="list-style-type: none"> <li>• Adventure Central</li> <li>• Chick Quest</li> <li>• Animal Science</li> </ul>
Oregon	Roger Rennekamp	Pat Willis Lynette Black	<ul style="list-style-type: none"> <li>• Tech Wizards</li> <li>• SET Middle School Program</li> <li>• Sustainable Living Schools</li> <li>• Science Mentoring</li> </ul>
Delaware	Kristin Cook	Katie Daly Mary Argo	<ul style="list-style-type: none"> <li>• Power of Wind</li> <li>• Agilent Tech</li> <li>• Wonder Wise</li> <li>• Science Lab</li> <li>• Robotics</li> </ul>
Connecticut	Laura Marek	Edith Valiquette Linda Horn Margaret Grillo	<ul style="list-style-type: none"> <li>• Animal Science</li> <li>• 4-H After School</li> <li>• Robotics</li> </ul>
North Carolina	Claudette Smith	Linda Semon Shannon Wiley	<ul style="list-style-type: none"> <li>• Water Quality</li> <li>• Envirocape</li> <li>• Fuel Cell Car</li> <li>• Robotics</li> </ul>
Iowa	Jay Staker Holly Bignall	Daleta Christensen Lisa Berklund	<ul style="list-style-type: none"> <li>• Robotics</li> <li>• Ag Environmental Day</li> <li>• Technology Club</li> <li>• Science Day Camps</li> <li>• Virtual Clubs</li> </ul>