

2012

Oregon 4-H Science Rich Handbook Series

**Focus on the
*4-H Foods Project***



Oregon State University
Extension Service

Welcome to 4-H Science

This handbook series was developed to help Oregon 4-H youth development professionals and volunteers become familiar with the national 4-H science framework and how to think intentionally about 4-H Science programming. It will help improve the understanding and delivery of science within appropriate 4-H projects.

4-H, with its direct connection to the Cooperative Extension System's cutting edge research and the resources of the nation's 106 land-grant universities and colleges, provides youth with hands-on learning experiences that foster exploration, discovery, and passion for the sciences. Science is one of the three national Mission Mandates for 4-H. 4-H Science programs support youth to develop science, technology, engineering and applied math (STEM) skills.

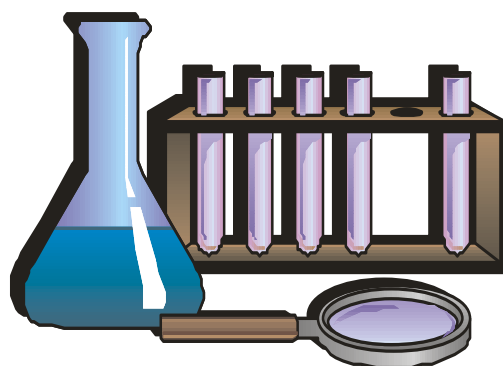
This handbook will

1. Define 4-H Science
2. Introduce tools to focus on 4-H Science in this project area
 - a. 4-H Science Checklist
 - b. 4-H Science Eight Essential Elements
 - c. Science Inquiry Flowchart
 - d. 4-H Science Logic Model
3. Provide Examples of Science Rich 4-H Inquiry Activities

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Why 4-H Science?

The National Academy of Science's 2007 *Rising Above the Gathering Storm* report stated that, "the United States presently faces a significant challenge - young people are not prepared with the necessary Science, Engineering and Technology workforce skills to compete in the 21st century." In their 2011 review of America's position five years later, entitled *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5*, the Academy committee's unanimous view is that our nation's outlook has worsened.

The 2009 National Assessment of Educational Program report indicates Oregon 8th grade students are proficient in math (37%) and science (35%) slightly above the national average. However, just 15% of Hispanics and 12% of Black 8th grade students are proficient in math compared to 41% of White students. For science, just 12% of Hispanics and 13% of Black 8th graders are proficient compared to 40% of White students. The percentage of Oregon 8th grade students who reported they "never or hardly ever" design a science experiment was 35%, compared to 39% nationally. The percent of Oregon 8th grade students who report that they "never or hardly ever" write reports on science projects was 43%, compared to 47% nationally.

The national the 4-H Science Mission Mandate targets addressing these needs at the local level through the broad range of 4-H projects which are based on science. 4-H Science programs reach more than 5.9 million youth in urban, suburban and rural communities across the country. 4-H Science programs support youth to develop science, technology, engineering and applied math (STEM) skills. Oregon 4-H youth development professionals and volunteers can help address this need using the resources and tools in this handbook.

1. The 4-H Science Checklist

The 4-H Science Checklist is provided in Appendix A. The checklist includes seven items that have been identified as the most critical program components to include in a 4-H Science Program. You may be thinking, “I don’t lead a 4-H Science Club! I’m just a Foods club leader.” The goal of the checklist is to help 4-H youth development professionals and volunteers identify and reinforce the science learning opportunities across a variety of 4-H projects.

A paragraph at the top of the check list explains, “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 outcomes articulated by the 4-H Science Logic Model. Additionally, it integrates the Essential Elements (of youth development programs) and engages participants in experiential and inquiry based learning.”

Let’s look at what should be included in the program components of a “Science Ready” 4-H experience.

✓ **National Science Education Standards**

These standards are used by Oregon’s Department of Education to develop the science benchmarks for K-12 education. The national standards provide a common and consistent base of quality content on which 4-H program design, development, delivery and assessment is built.

In 2011 the National Academy of Sciences released *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Future science and engineering education standards will be based on this framework. The framework emphasizes the importance of engaging students in eight foundational practices of science and engineering in the K-12 science and engineering curriculum. These are presented in Section 3 of this handbook.

✓ **4-H Science Abilities**

This section includes a list of 30 science abilities or practices that are skills used in science, engineering and technology. These abilities can be used across 4-H project areas to help youth unleash their natural curiosity about the world. Youth will use these skills and understand what it means to think and act like a scientist.

✓ **Youth Development- Essential Elements**

Oregon 4-H youth development professionals and volunteers are already addressing these opportunities in their work with youth. The four needs of youth to experience mastery, independence, belonging and generosity are supported by the Eight Essential Elements of Positive Youth Development. Specific examples of how 4-H youth development professionals and volunteers can implement these are provided in Section 2, 4-H Science Core Concepts: Eight Essential Elements of Youth Development in this handbook.

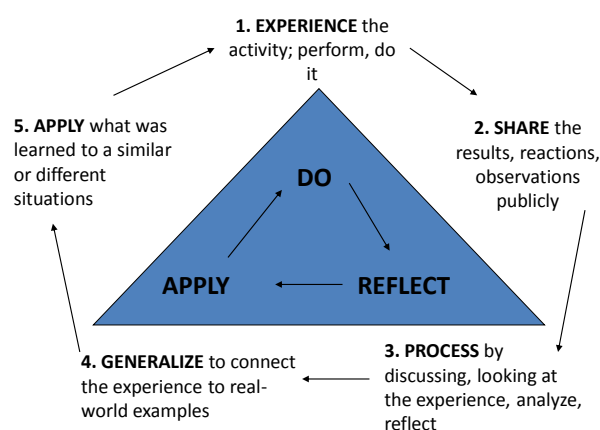
✓ **Trained, Caring Adults and Volunteers**

Oregon 4-H youth development professionals and volunteers are provided a variety of opportunities, including this handbook, to increase their skills as front-line youth workers. This handbook will help you to incorporate the 4-H Science Checklist, 4-H Science Logic Model, Science Inquiry Flowchart, and 4-H Science Core Competencies into your programming.

✓ **An Experiential Approach**

Oregon 4-H youth development professionals and volunteers are familiar with the 4-H experiential learning model. All 4-H project materials rely on this approach to create and reinforce learning.

4-H Experiential Model



✓ **Inquiry to Foster Creativity and Curiosity**

“Inquiry is a process that all individuals naturally use in approaching new situations and solving problems in life. By engaging in inquiry, ...children...gain experience...that will improve their capacity to handle life situations and solve everyday problems.” (Edmund Marek and Ann Cavallo, 1997). Inquiry can happen in a variety of ways across 4-H programs. Ideas on encouraging inquiry and use of the Science Inquiry Flowchart (Appendix C) will be presented in Section 3 of this handbook.

✓ **4-H Science Logic Model**

The 4-H Science Logic Model articulates the opportunity to achieve science outcomes across 4-H education programs. It is provided in Appendix D. Outcomes happen at three levels. Short-term outcomes are those that happen immediately after an education experience such as knowledge gains. Intermediate or long-term outcomes happen after the learner has a chance to integrate their new knowledge into different actions.

2. 4-H Science Core Competencies: Eight Essential Elements of Youth Development

One framework for understanding youth development in 4-H are the eight essential elements, which provided the structure for development of the 4-H Science Core Competencies. The 4-H Science Core Competencies identify specific actions or behaviors of 4-H youth development workers and volunteers that create a positive atmosphere or context for learning. The four needs of youth to experience **mastery, independence, belonging** and **generosity** are supported by the Eight Essential Elements of Positive Youth Development. A 4-H Science Competency Self Assessment is provided in Appendix B.

Caring Adult (Belonging)

4-H youth development professionals and volunteers understand that each young person benefits from a positive relationship with a caring adult by:

1. Communicating the capacity of all youth to learn and experience success.
2. Being willing to learn alongside youth.
3. Being comfortable not having all the answers.
4. Demonstrating support for all youth.
5. Understanding and caring about youth and their families.
6. Appreciating the context in which youth and families live.

Safe Environment (Belonging)

4-H youth development professionals and volunteers create an emotionally and physically safe learning environment by:

1. Modeling strategies for conflict resolution.
2. Encouraging youth to share new ideas and different perspectives.
3. Modeling and facilitating how to give and receive constructive criticism.

Inclusive Environment (Belonging)

4-H youth development professionals and volunteers design inclusive learning environments by:

1. Promoting teamwork and cooperation.
2. Providing opportunities for youth to teach and learn from each other.
3. Demonstrating respect for others.
4. Fostering an environment of mutual respect for others.

See Oneself in the Future (Independence)

4-H youth development professionals and volunteers nurture an atmosphere of optimism and a positive belief in the future by:

1. Encouraging the belief that all youth can learn science or pursue science careers.
2. Creating a science-friendly learning environment.
3. Promoting science careers for all youth, regardless of their gender, race, or ethnicity.
4. Demonstrating how science can improve the world.

Values and Practices Service to Others (Generosity/ Mastery)

4-H youth development professionals and volunteers encourage an ethic of caring and civic responsibility by:

1. Helping youth connect to the community through service projects.
2. Encouraging empathy for others.
3. Engaging youth in real world science activities that consider the needs of others.
4. Understanding the positive and negative effects that science has on humans.

Opportunities for Self-Determination (Independence)

4-H youth development professionals and volunteers encourage and support independence in youth by:

1. Designing experiential, inquiry-based opportunities for youth to learn 4-H Science skills.
2. Challenging youth to explore new or different 4-H Science projects and areas of learning.
3. Supporting youth in achieving their goals in the face of setbacks.
4. Knowing how to foster an increasing development of skills in youth.

Opportunities for Mastery

4-H youth development professionals and volunteers provide opportunities for youth to develop skills, competence, and expertise by:

1. Designing experiential, inquiry-based opportunities for youth to learn 4-H Science skills.
2. Challenging youth to explore new or different 4-H Science projects and areas of learning.
3. Supporting youth in achieving their goals in the face of setbacks.
4. Knowing how to foster an increasing development of skills in youth.

Engagement in Learning (Mastery)

4-H youth development professionals and volunteers encourage youth to direct and manage their own learning by:

1. Assisting youth in setting realistic goals of their own choice.
2. Encouraging an inquiry approach to learning and exploration.
3. Providing sufficient time and an appropriate environment for thorough learning.

3. 4-H Science Inquiry in Action

The *National Science Education Standards* (1996) employ Science as Inquiry as a skill across all science content areas. Like life skills in traditional 4-H projects, the process of using inquiry supports content learning. Oregon's 4-H Science Inquiry Flowchart (Appendix C) shows the relationship between the 4-H Experiential Learning Model and the steps applied in science inquiry. These steps also align well with the National Research Council's (NRC) eight foundational practices for science and engineering education presented in *A framework for K-12 science education* (2011), see Table 1.

On the Science Inquiry Flowchart (Appendix C), note that the first two steps in the process are lead by the coach or leader. These are, "1. Determine what learners know or have observed. Identify knowledge gaps or misunderstandings." and, "2. What do learners want to know? What questions do learners have?" These two steps are where the leader introduces the topic and engages the learners in using their inquiry process skills. Then the activity should move to a more learner centered model.

Learning to lead learner-centered, inquiry based activities can be a challenge for 4-H youth development professionals and volunteers who are more familiar with prescribed project activities which follow cookbook-like steps to a known outcome. With repeated application of the inquiry model – learning by doing – leaders and learners become familiar with the steps of science inquiry and science practices. Learners will soon take initiative and become engaged in designing their own learning experiences.

Steps 3 through 10 of the flowchart are intended to be primarily learner driven. For ease of management, youth can be put into teams to work on an inquiry activity. There are a variety of ways the leader can proceed with facilitating inquiry. In *Guided Inquiry*, learners are provided with a problem to investigate and the materials necessary to carry out the investigation. The learners then devise their own procedure to plan and carry out an investigation, analyze and interpret their data, and evaluation and communicate their findings. The state 4-H project page for Science, Engineering and Technology (<http://oregon.4h.oregonstate.edu/science-engineering-and-technology>) has a link to ten videos that show examples of how to lead guided inquiry activities in a selection of 4-H projects.

A second way of facilitating a science activity is called *Open Inquiry*. The learners formulate their own problem to investigate and devise strategies to carry out their investigation (Steps 4-6). This can include determining which equipment to use to collect information from a selection provided and creating their own data chart to record information.

Science education can be improved by immersing learners in the process of using scientific knowledge and practices to "do" science. Informal learning environments are ideal settings for learners to practice skills necessary for scientific inquiry. Experiential learning may be defined as learning based on personal experiences or direct observation. Experience and

observation are key to the scientific inquiry process. An example of a project activity using inquiry will be presented in Section 4 of this handbook.

Table 1: Correlation of Foundational Practices for Science & Engineering Education and the Science Inquiry Flowchart

National Research Council's Foundational Practices for Science and Engineering Education	Science Inquiry Flowchart Elements
(1) Asking questions (for science) and defining problems (for engineering)	(3) Team asks a question which can be explored through scientific investigation.
(2) Developing and using models	(4) Team designs a simple scientific investigation.
(3) Planning and carrying out investigations	(4) Team designs a simple scientific investigation.
	(5) Team selects appropriate equipment to collect data, designs a data sheet (if needed).
	(6) Team collects data and completes data sheet.
(4) Analyzing and interpreting data	(7) Team describes their investigation and their results.
	(8) Team thinks critically and logically to make the relationship between evidence and explanations and presents their analysis of the findings.
(5) Using mathematics and computational thinking	(7) Team describes their investigation and their results.
	(8) Team thinks critically and logically to make the relationship between evidence and explanations and presents their analysis of the findings.
(6) Constructing explanations (for science) and designing solutions (for engineering)	(8) Team thinks critically and logically to make the relationship between evidence and explanations and presents their analysis of the findings.
(7) Engaging in argument from evidence	(8) Team thinks critically and logically to make the relationship between evidence and explanations and presents their analysis of the findings.
	(9) Through group discussion team applies findings to everyday experiences or real-world examples.
(8) Obtaining, evaluating, and communicating information	(8) Team thinks critically and logically to make the relationship between evidence and explanations and presents their analysis of the findings.
	(9) Through group discussion team applies findings to everyday experiences or real-world examples.

4. Examples of a Science Rich 4-H Foods Inquiry Activities

4.a) *Biochemistry of Milk: Milk on the Move*

Background Information:

Milk is an interesting and somewhat unusual liquid. It is an emulsion which is a mixture of two unbendable liquids and a colloid (a mixture where one substance is dispersed evenly throughout another). Milk is butterfat globules within a water-based fluid.

Materials List:

- A small bowl
- Room temperature whole milk
- Food coloring
- Dish soap
- Tooth picks
- Fat-free milk
- 2% milk
- Heavy cream
- Chocolate milk

Experience/ “What to Do”:

Pour a cup of milk into the bowl and let settle.

Place three drops of each color into the milk making sure they do not overlap each other.

Observe.

Dip the toothpick into the dish soap and touch the milk in the middle of the bowl. Observe.

Share ...

Ask students to describe what they observed happening after each drop of food coloring was added to the bowl of milk.

Ask students to describe what they observed when they first touched the milk with the soap covered toothpick.

Ask students to describe what they observed in the time following the dish soap being introduced to the milk mixture.

Reflect ...

What other questions do you have now that you have conducted this experiment?

- Will other types of milk react the same? (chocolate milk, fat-free milk, heavy cream?)
- Does the temperature of the milk make a difference?

(To answer the first question, repeat the experiment using various types of milk. To answer the second question, repeat the experiment using cold and hot (not boiled or scorched) milk.)

Generalize ...

Which type of milk created the most movement? Why?

What temperature of milk created the most movement? Why?

Apply ...

How can we use the information we just learned in cooking?

4.b) Biochemistry of Milk: An Amazing Change Artist

Background Information:

Milk is an interesting and somewhat unusual liquid. It is an emulsion which is a mixture of two unbendable liquids and a colloid (a mixture where one substance is dispersed evenly throughout another). Milk is butterfat globules within a water-based fluid.

Materials List:

- A small jar with a tight fitting lid
- Room temperature heavy cream
- Measuring cups
- Various other milks such as: whole milk, 2%, chocolate

Experience/ “What to Do”:

Pour a $\frac{1}{4}$ cup of cream into the jar and seal. (Jar should be no more than $\frac{1}{2}$ full.)
Shake the jar for 15-20 minutes. Observe the changes that occur.

Share ...

- As the students shake the jar, ask them to describe what they are observing. (The milk will go through several changes before the final product is revealed. Make sure they don't stop shaking during the whipped cream stage. When shaken long enough the whey will suddenly separate from the fat leaving a clump of butter and a milky liquid which is true butter milk.)
- Ask students to describe each stage of development.
- Ask students what final product was produced. (butter)
- Ask students what indicated a chemical reaction occurred? (According to Chemicals Are Us, an OMSI curriculum, there are 5 indicators of a chemical reaction having occurred: Temperature change, Color change, Gas given off, Precipitate formed, and/or New substance formed)

Reflect ...

What other questions do you have now that you have conducted this experiment?

- Will other types of milk react the same? (whole milk, 2%, chocolate?)
- Does the temperature of the milk make a difference?

Generalize ...

Which type of milk created butter? Why?

What temperature of milk created butter? Why?

Apply ...

How can we use the information we just learned in cooking?

Interesting Facts:

- The cream is agitated to shake the fat globules out of position, leading to a clumping together of the fat globules. The clumping first allows tiny air bubbles to be trapped in the cream, forming a light and airy product called *whipped cream*. If the agitation is

continued, the fat globules start to clump so much that the air can no longer be held by the cream; the whipped cream seizes, and butter forms. This process is called **churning**.

- Adding a marble to the jar makes the process more efficient.
- Butter is a water-in-oil emulsion of the milk fat (also known as the butterfat) and the water from the cream. It is about 80% fat and contains fat-soluble vitamins (vitamin A, vitamin D and vitamin E).
- It takes about 21 pounds of fresh milk to make just 1 pound of butter.

4.c) Biochemistry of Milk: An Amazing Change Artist II

Background Information:

Milk is an interesting and somewhat unusual liquid. It is an emulsion which is a mixture of two unbendable liquids and a colloid (a mixture where one substance is dispersed evenly throughout another). Milk is butterfat globules within a water-based fluid.

Materials List:

- A good quality resealable plastic sandwich-sized bag
- A good quality resealable plastic quart-sized bag
- Ice
- Rock salt
- Sugar
- Vanilla
- Measuring cups
- Hand towels and/or gloves
- Thermometer
- Cold whole milk
- Various other milks such as:
 - Chocolate
 - Half & Half
 - Skim
 - 2%

Experience/ “What to Do”:

- Measure $\frac{1}{4}$ cup of milk and pour into the small re-sealable plastic bag.
- Seal the bag and carefully mix by kneading with your hand.
- Unseal, remove as much air as possible and reseal. Note: be sure it is completely sealed.
- Place the small bag inside the larger re-sealable plastic bag. Add ice to the larger bag, filling about $\frac{2}{3}$ full and surrounding the small bag.
- Note the temperature inside the larger bag.
- Add $\frac{1}{2}$ cup of rock salt to the ice. Remove as much air as possible and seal the bag. Note: be sure the bag is completely sealed.
- Manipulate the bag for 10 – 15 minutes. Observe changes over time. Note: may need to wrap the bag in a hand towel to protect your hands from the cold or wear gloves.
- Note the temperature inside the larger bag filled with ice and salt.
- Carefully remove the small bag from the large, wipe dry and clean of salt before opening the small bag.

Share ...

What was the temperature inside the large bag after adding the ice? (32 degrees F)

What was the temperature inside the large bag at the end of process? (between 10-20 degrees F)

What caused the difference? (Salt lowers the freezing point of water, thus enabling the ice to create colder temperatures needed to freeze the milk mixture.)

Ask students what indicated a chemical reaction occurred? (According to Chemicals Are Us, an OMSI curriculum, there are 5 indicators of a chemical reaction having occurred: Temperature change, Color change, Gas given off, Precipitate formed, and/or New substance formed)

Reflect ...

What other questions do you have now that you have conducted this experiment?

- Will other types of milk react the same? (The fat component adds richness of flavor, contributes to a smooth, creamy texture.)
- What would make the resulting product taste better? (Add 1 Tablespoon of sugar and ½ teaspoon of vanilla.)
- Does the amount of rock salt make a difference? (Water will normally freeze at 32 degrees F. A 10% salt solution freezes at 20 degrees F, and a 20% solution freezes at 2 degrees F.)

Generalize ...

Which milk created the best tasting ice cream? Why?

Which milk created the creamiest texture? Why?

Apply ...

How can we use the information we just learned in cooking?

Interesting Fact:

- Why does ice cream contain so much sugar? The coldness of the ice cream numbs our taste buds thus diminishing their sensitivity. In order for the ice cream to taste sweet, more sweetener is needed.
- In the commercial ice cream business sugar serves another purpose. It lowers the freezing point of the ice-cream mixture and decreased the formation of ice crystals. Home freezers are not cold enough for storing ice-cream and the frequent trips the container takes from the freezer contributes to the formation of ice crystals (the ice-cream's water content separates from the fat content). These crystals give the ice cream an icy, grainy texture.

Reference

Jamison, K. & Walahoski, J., 2010. *4-H Science 101: Development, Delivery and Assessment of 4-H Science Programs*. National 4-H Council.

National Research Council (NRC). 2011. *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press.



Appendix A








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...*

	<p>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/</p>
	<p>Are you providing children and youth opportunities to improve their Science Abilities?</p> <p>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</p>

	<p>Are you providing opportunities for youth to experience and improve in the Essential Elements of Positive Youth Development?</p> <p>Do youth get a chance at mastery – addressing and overcoming life challenges in your programs?</p> <p>Do youth cultivate independence and have an opportunity to see oneself as an active participant in the future?</p> <p>Do youth develop a sense of belonging within a positive group?</p> <p>Do youth learn to share a spirit of generosity toward others?</p>
	<p>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?</p>
	<p>Are activities led with an experiential approach to learning?</p>
	<p>Are activities using inquiry to foster the natural creativity and curiosity of youth?</p>
	<p>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?</p>

Appendix B- 4-H Science Competency Self Assessment

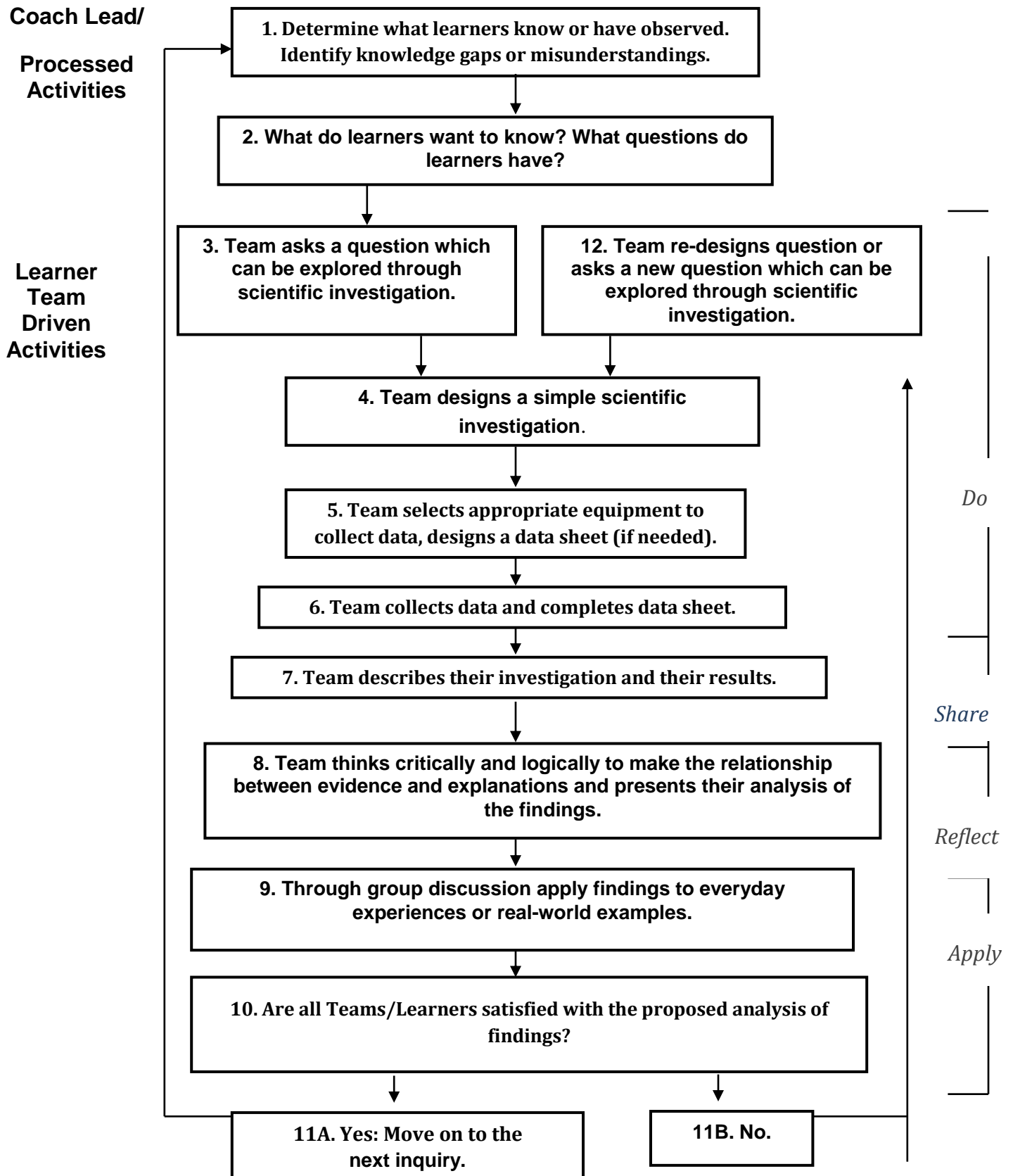
Please fill in the circle that tells you how much you are capable of using the knowledge and skills in each of these areas when you work with youth in 4-H Science programs.

	0 Never	1 Sometimes	2 Usually	3 Most of the Time	4 Always
CARING ADULT					
I use language of respect	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I listen to youth in a nonjudgmental way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I demonstrate shared leadership through youth-adult partnerships	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I encourage youth to think about what they are learning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I make verbal contact with all youth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I encourage learners when they experience setbacks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I offer praise and encouragement when youth take initiative and leadership	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I identify, build on, and celebrate the potential of all youth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I respect youth of different talents, abilities, sexual orientations, and faiths	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
INCLUSIVE ENVIRONMENT (BELONGING)					
I help youth feel welcome and part of a group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I establish a climate of fairness and openness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I respond positively to the ranges of youths' feelings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I cultivate a sense of togetherness among youth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I value and act upon the ideas of others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I serve as a role model for inclusion and tolerance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I initiate, sustain, and nurture group interactions and relationships	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
SAFE ENVIRONMENT					
I conduct myself in a calm manner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I reduce or eliminate physical and environmental hazards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I re-emphasize ground rules related to conduct	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I intervene when safety demands it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
SEE ONESELF IN THE FUTURE					
I project an optimistic, positive manner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I reinforce the idea that all youth can succeed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I offer positive encouragement and support even in the face of setbacks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I talk about the future and youth's role in it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

VALUES AND PRACTICES SERVICE TO OTHERS	0 Never	1 Sometimes	2 Usually	3 Most of the Time	4 Always
I encourage youth to contribute to the communities in which they live	0	0	0	0	0
I voice support for giving back to the community through service	0	0	0	0	0
I believe in science's role in improving communities	0	0	0	0	0
I provide opportunities for youth to link their experiences to citizenship	0	0	0	0	0
I identify opportunities for youth to become civically engaged	0	0	0	0	0
OPPORTUNITIES FOR SELF-DETERMINATION					
I provide experiences that encourage youth to share evidence	0	0	0	0	0
I identify opportunities for youth to compare claims with each other	0	0	0	0	0
I articulate strategies for data collection and analysis	0	0	0	0	0
I work with youth to identify sources of information	0	0	0	0	0
I actively consult, involve, and encourage youth to contribute to others	0	0	0	0	0
I provide opportunities for youth to determine program expectations and direction	0	0	0	0	0
ENGAGEMENT IN LEARNING					
I guide youth in learning for themselves	0	0	0	0	0
I create opportunities for problem solving via discussion, debate, and negotiation	0	0	0	0	0
I work with youth to establish appropriate goals for their age	0	0	0	0	0
I provide opportunities for youth to link their experiences to the real world	0	0	0	0	0
I use a variety of questioning and motivational approaches	0	0	0	0	0
I use multiple learning approaches to meet learners' needs	0	0	0	0	0
OPPORTUNITIES FOR MASTERY					
I suggest challenges that can be explored by direct investigation	0	0	0	0	0
I encourage youth to make predictions	0	0	0	0	0
I assist youth in developing hypotheses related to their investigations	0	0	0	0	0
I allow youth to conduct formal and open-ended tests and experiments	0	0	0	0	0
I have youth discuss their finding with each other and evaluate evidence critically	0	0	0	0	0
I encourage youth to share their knowledge by teaching others and leading new activities	0	0	0	0	0
I help youth see setbacks as opportunities for new explorations	0	0	0	0	0
I support youth to set new goals, and try new ideas and approaches	0	0	0	0	0
I provide opportunity for youth to use appropriate technology	0	0	0	0	0

Appendix C- Science Inquiry Flowchart

Science Inquiry Flowchart



Appendix D- 4-H Science Logic Model

4-H Science Logic Model

