

2012

Oregon 4-H Science Rich
Handbook Series

Focus on the
4-H Marine Science
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.

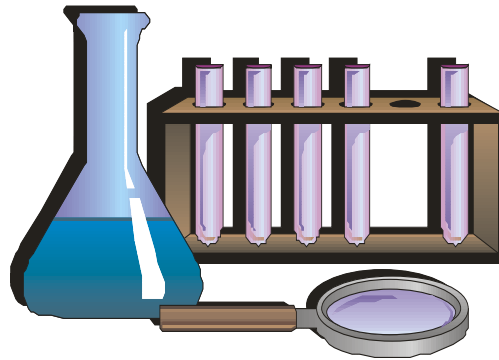
This handbook will

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 An Example of a Science Rich 4-H Inquiry Activity

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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 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 Marine 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.

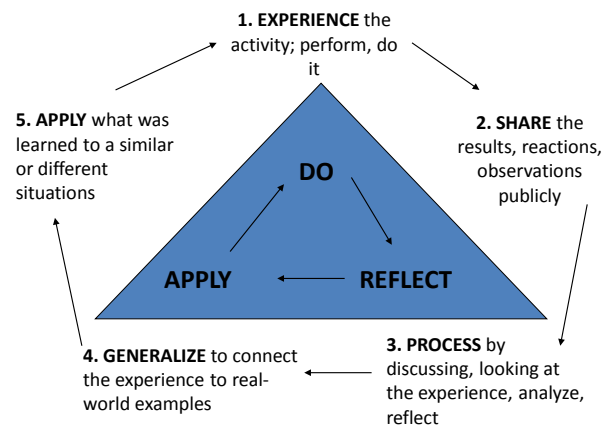
✓ **Trained, Caring Adults and Volunteers**

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 led 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. An Example of a Science Rich 4-H Marine Science Inquiry Activity

Background for the Activity

The Pacific Ocean on the United States' west coast and the Atlantic Ocean on the east coast have modifying effects on the weather on our continent. The movement of water in evaporation, precipitation and storage in oceans and on land is called the water cycle. This movement also redistributes energy. For more information and an animation on the water cycle see <http://www.epa.gov/climatechange/kids/index.html>, "Let's Learn about the Water Cycle" This may be a useful tool to introduce this lesson to youth.

The sun is the major source of energy in our atmosphere. This energy reaches the planet in the form of radiation. (Is all radiation bad? From sci-fi movies and cartoons, learners may have the misconception that people should never be exposed to radiation.)

Radiation is the transfer of energy by electromagnetic waves. On Earth, we experience the sun's radiation as light and heat. Heat is the transfer of energy from an object with a higher temperature to an object with a lower temperature.

What happens to the energy that enters Earth's atmosphere? Clouds and the atmosphere absorb about 20 percent of the energy and reflect another 25 percent back into space. The Earth's surface absorbs about 50 percent of the energy and reflects about 5 percent back into space. One reason life on Earth is possible is the delicate balance our unique atmosphere produces between the energy Earth receives and the energy it loses. The atmosphere on Venus is composed of thick gasses and clouds that trap radiation, similar to a closed car on a sunny day. The atmosphere on Mars is so thin that most radiation escapes. The atmospheres of Venus and Mars cannot support life as we know it.

Water is one of the requirements of life found on Earth. Water moves between the atmosphere and Earth in the water (hydrologic) cycle. The majority of water on our planet, approximately 97%, is found in the oceans. The sun provides the energy that "powers" the water cycle. Radiation from the sun causes evaporation of water from lakes, rivers, and oceans and transpiration from plants. When radiation is absorbed by water, this energy heats the water. As the water warms, its molecules move farther apart from each other. In the process of evaporation, the warmed water changes from a liquid to a gas, called water vapor.

Water vapor rises in the atmosphere, eventually forming clouds. Clouds are made up of many tiny water droplets. The water droplets collide with each other in the cloud and form larger drops. The water molecules move closer to each other as they cool. When the drops grow so large that they can no longer stay suspended in the cloud, they fall back to Earth as precipitation (rain, snow, or hail). Once back on Earth, the water drops may take a variety of paths return to the ocean and then return to the clouds in this endless process that is the water cycle.

Leading the Activity

Begin at boxes 1 and 2 of the Science Inquiry model. Ask learners some questions to determine what they know about how the Earth receives energy from the sun. What do they know about the water cycle? What is the driving source of energy for the water cycle? (The sun.) Have any of them ever had a sunburn? How is a sunburn (radiation) different from a burn you might get from a hot object such as a stove top or candle flame (conduction)? A sunburn can be a "bad" result of radiation the Earth receives from the sun. What are some good results? Have any of the learners ever made sun tea? Lead a discussion based on the information provided in the "Background" section. Be sure learners have a good grasp of how the water cycle functions. Adapt the information to the age of the learners.

After the introductory discussion with the learners, organized them in teams of three to five persons each. Follow the steps outlined in the 4-H Science Inquiry Flowchart. Ask learners how they might measure the changes to objects on Earth when the objects receive radiant energy from the sun. (Flowchart Box 3.) Referring to the 4-H Science Checklist, youth may use Science Abilities such as Predict, Hypothesize, Evaluate, Research a Problem, Communicate, Infer, and Compare.

Ask each team select a question. Coach the teams to select questions that can be answered by a simple experiment. Some examples are:

- Does ocean (salt) water evaporate faster than fresh water?
- Do objects of different colors absorb energy differently?
- How warm does water have to become for evaporation to start?
- Does the water in a pond get warm when the sun shines?
- Does the temperature of a pond change throughout the day?
- Does water evaporate from a pond?

Encourage older learners to use an "**If** , **then**" hypothesis format for their questions. The question "Does water become warmer in the sun?" becomes the hypothesis, "**If** we leave water in the sun, **then** it will become warmer."

Once all the teams have selected a question ask them to share their question with the group. It is best if each team poses a different question or hypothesis. In this way the whole group will learn more about sun power by the end of the lesson. Also at that time the leader can determine if the learners have asked a question they can answer with the available materials.

Before learners design experiments, box 4, lead a discussion to check for understanding of experimental design. In an experiment, the *dependent variable* is the event studied and expected to change when the *independent variable* is changed. *Controlled variables* are the things that are the same.

A team of youth might state their hypothesis, for example, as "We will start with 2 glasses of A and B. Each will contain 1 cup of water at room temperature. **If** stir 2 teaspoons of

salt into glass B, and place both glasses in the sun **then** the water in glass B will evaporate more quickly than the water in glass A.”

- Independent variables answer the question “What do we change?”
 - The types of water, fresh or salt, is the independent variable.
- Dependent variables answer the question “What do we observe?”
 - The speed of evaporation of the water in glasses A and B.
- Controlled variables answer the question “What do we keep the same?”
 - The type of glasses, the volume of the water in both glasses, the starting temperature of the water, the exposure to glasses to the sun and the length of time of the exposure to the sun will be the same.

Learners can now move through steps 4 through 11 of the Inquiry in Action flow chart. Science Abilities they have an opportunity to use in Open Inquiry include Question, Infer, State a Problem, Predict, Hypothesize, Plan an Investigation, Cooperate, Test, Measure, Use Tools, Observe, Collect data, Organize, Summarize/Relate, Interpret/Analyze/Reason, Communicate, Compare and Redesign.

Have the materials suggested in the list below available for learners to use for collecting data. If needed, explain how to use the materials or equipment.

- Thermometers
- Clear plastic cups
- Fresh water
- Salt water. Recipe for Ocean water: 2 teaspoons table salt / 1 cup water or use 1.5 teaspoons of a salt water aquarium product/ cup water.
- Supply of construction paper in both light and dark colors
- Supply of plastic wrap and aluminum foil
- Tape

Youth may think of additional items they wish to use for their experiments. Provide these if you have them. Take the materials outside and have learners collect the data they believe they need to answer their selected question (Flowchart Box 6). Learners can now use Science Abilities such as Measure, Collect Data, Draw/Design, Use tools, Observe, Communicate, Organize, Infer, Plan and Investigation, and Compare.

After they have collected data, ask each team to analyze and interpret their results (Flowchart Box 7) and provide a summary report to the rest of the group (Flowchart Box 8). Youth can use the Science Abilities to Observe, Organize, Summarize/Relate, Interpret/ Analyze/ Reason, and Communicate.

Once all the groups have reported their findings and explanations lead a discussion to identify what has been learned about "Sun Power" from the investigations. Are there new questions the group would now like to ask about how objects on Earth change when they receive energy from the Sun (Box 9)?

At step 10 on the flowchart the question is, “Are all Teams/Learners satisfied with the proposed analysis of findings?” If the answer is, “yes” they can move on to the next inquiry. If the answer is, “No,” the flowchart takes them up to step 12. At step 12 “Team re-designs question or asks a new question which can be explored through scientific investigation.” This is the cyclical nature of science. In formal education youth rarely have the chance to re-design a project. Allowing learning by trial and error supports the experiential model and gives youth control of their experience.

Remember that item three on the 4-H Science Checklist is the Essential Elements. In this activity 4-H youth development professionals and volunteers can create a positive learning environment by being willing to learn alongside youth and by being comfortable with not having all the answers.

An important skill for youth to practice as they learn to think and act like a scientist, is how to communicate ideas and discoveries. Youth have the opportunity to practice many of the science abilities on the 4-H Science Checklist by creating a Science Investigation Display for a 4-H fair event. A description of the fair class, the display requirements and the judging criteria are provided in the Science section of the State 4-H Fair book.

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"/>

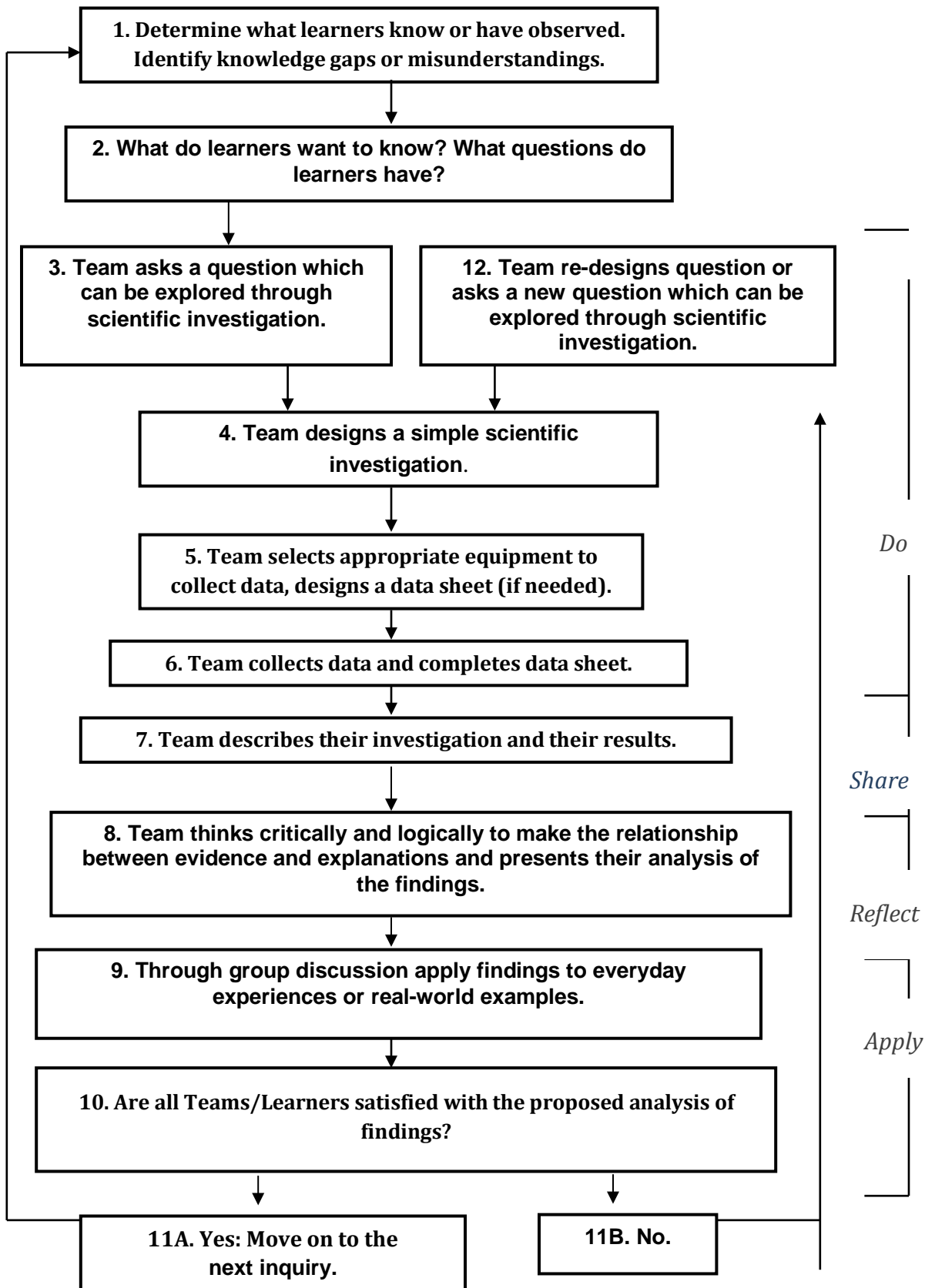
VALUES AND PRACTICES SERVICE TO OTHERS	0 Never	1 Sometimes	2 Usually	3 Most of the Time	4 Always
I encourage youth to contribute to the communities in which they live	0	0	0	0	0
I voice support for giving back to the community through service	0	0	0	0	0
I believe in science's role in improving communities	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

**Coach Lead/
Processed
Activities**

**Learner
Team
Driven
Activities**



Do

Share

Reflect

Apply

Appendix D- 4-H Science Logic Model

4-H Science Logic Model

