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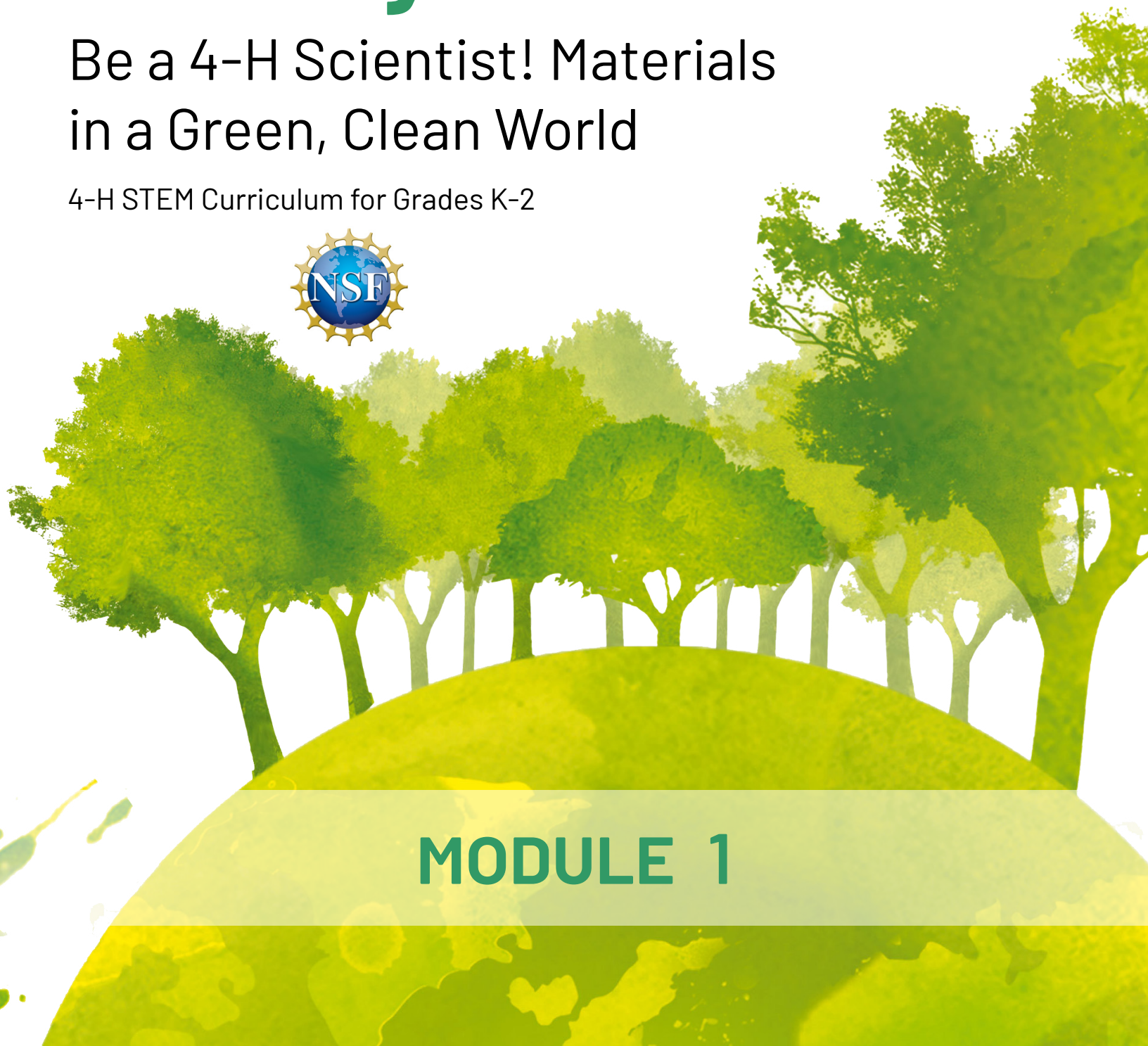
Center for
Sustainable Polymers

4-H Polymers

Be a 4-H Scientist! Materials in a Green, Clean World

4-H STEM Curriculum for Grades K-2



MODULE 1

Be a 4-H Scientist! Materials in a Green, Clean World

4-H STEM Curriculum for Grades K-2

4hpolymers.org

The themes of these modules touch on the prevalence and impact of plastics in everyday life. Plastics are versatile materials that come in different shapes, sizes, and exhibit different material properties. Scientists and engineers are working on new ways to create, use, and recycle plastics, so we can use plastics for their many advantages and lessen their effects on our environment.

Each module will include "Tips for Facilitators" as well as opportunities to use "I Wonder" Boards, science journals, and math. In addition, these modules incorporate the *SciGirls* Seven best practices for gender-equitable STEM learning. We encourage instructors to collect feedback throughout this module and submit via this evaluation form: 4hpolymers.org/evaluation.

"I Wonder" Boards

These boards should be used to track children's questions and ideas during the lesson for further investigation. This tool promotes experiential learning by youth while encouraging curiosity and discovery. Basic "I Wonder" Boards have "I Wonder…" written at the top of a large sheet or white board.

Science Journals

Journals help youth keep track of what they've noticed and learned during the activities. Journals promote a science identity and allow youth to reflect on their thoughts and feelings. For children who are unable to write, drawing pictures is a good substitute.

Using Math

Providing youth opportunities to use math and numbers are important for developing their math skills at a young age. Math is important to science because it allows definitive answers to be found and can help youth find out if something has changed.

SciGirls Seven

Based on educational research, the *SciGirls* Seven best practices are used to target and engage girls in STEM learning but have also been proven to work with all learners, including underrepresented youth. See *SciGirls* Seven handout at the back of the module for a more detailed explanation.

Module 1

What is a Scientist? Engaging youth as scientists and engineers

BY ANNE STEVENSON

Module Introduction

MODULE SUMMARY

In this module, children are introduced to the role of scientists through children's literature and several experiments. In **Activity A**, the children consider the question: "What is a scientist?" In **Activity B**, children are encouraged to use their senses and wonder about the world around them using mystery boxes and hydrogels. In **Activity C**, children explore the roles of engineers and reflect on how they may act like scientists and engineers in their everyday lives.

Total lesson time needed for Module 1: **60–80 minutes**

MODULE FOCUS

Learning Objectives	• Youth will use their senses to make observations. • Youth will recognize that (or confirm how) they often act as scientists and engineers in their daily lives, using descriptors from the two books they read in this module.
Science & Engineering Practices	• Youth will engage in the following NGSS Practices: asking questions and defining problems; analyzing and interpreting data; constructing explanations.
Concepts & Vocabulary *Incorporate and define vocabulary & concepts organically throughout the lesson. Check for understanding periodically to reinforce concepts. Encourage youth to use new terms.*	• **Scientists:** people who ask questions to learn about the world around them • **Engineers:** people who use knowledge to invent, design, or improve a solution to a problem • **5 senses:** smell, touch, sight, taste, hear

Facilitator Preparation

BACKGROUND INFORMATION FOR THE FACILITATOR

Most children do not realize the things they do in their daily lives that are comparable to the work of scientists and engineers. More commonly children will visualize adults wearing lab coats, building bridges, and using specialized tools. Children are natural scientists and engineers, exploring and changing the world through design, making, and playing. The goal of this module is to help children become aware of the science and engineering they do and begin to identify themselves as scientists and engineers. This module assists us in understanding children's preconceptions about scientists and engineers, guiding them to a fuller understanding of what scientists and engineers do, and reinforcing the idea that all of us can act as scientists and engineers do.

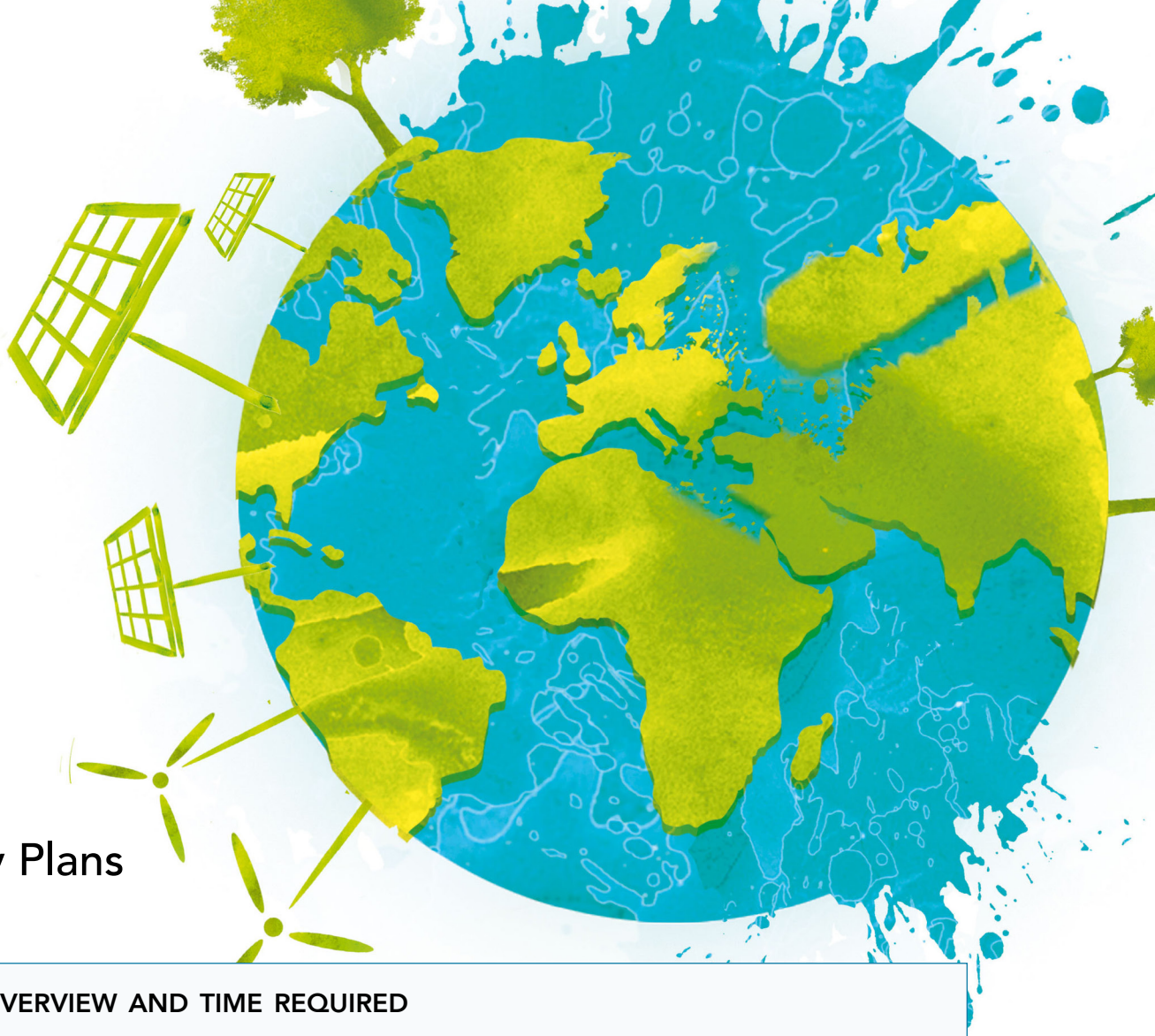
While the professional communities of science and engineering often require specialized training and tools, anyone can learn to engage in the processes and practices of science and engineering! This module introduces the concept of "wondering," how important it is for adults to model and encourage this sense of wonder in children, and how these "wonders" are often turned into questions that can be investigated or studied.

PREPARING TO TEACH THIS MODULE

Estimated prep. time:	**1–2 hours** if preparing Mystery Boxes; **15–20 minutes** if Boxes have been prepared (plus **3–4 hours** for soaking hydrogels).
What to prepare:	• Gather all supplies listed under **Materials List**. • Consider how you will divide youth into smaller groups for the various activities. • For **Activity B**: Create the 3 **Mystery Boxes** using non-transparent shoe boxes, photo boxes, plastic tubs, or similar box. Each must have a removable lid (*see materials list*). • Hydrate the hydrogel crystals in a bowl or ziplock bag for 3–4 hours (*see directions on package*). After hydrated, divide into small cups or plates: 1 cup or plate for every 2 children.

MATERIALS LIST FOR MODULE 1

Books:	☐ *What is a Scientist?* (Barbara Lehn, 1998) ☐ *Design. Invent. Create.* (Engineering for Everyone, 2014)
Items for Mystery Boxes (MB):	☐ 3 non-transparent shoe boxes, plastic tubs, or similar boxes with removable lids for the MB's: ☐ **MB #1**: 2 small balls and 3–4 small plastic animal figures, or plastic toy cars ☐ **MB #2**: various interesting looking shells or rocks ☐ **MB #3**: 2–3 types of dried beans or seeds, (e.g. lima beans, sunflower seeds, split peas)
Other materials:	☐ Hydrogel Crystals (super absorbent polymer crystals). *Ordered from science supply stores such as: stevespanglerscience.com* ☐ Flip chart paper and markers ☐ Paper towels ☐ Large bowl, and 10–12 oz. clear plastic cups or small bowls for crystals (1 cup for every 2 children)



Activity Plans

ACTIVITY OVERVIEW AND TIME REQUIRED

As a facilitator, plan to **arrive 15–20 minutes early to set up the lesson materials**. Additionally, allow **3–4 hours** prior to the lesson to soak hydrogels. If you have not yet prepared the Mystery Boxes for Activity B, you will need an additional **1–2 hours** of preparation time for creating Mystery Boxes.

Activity A: What is Scientist?:	15–20 minutes
Activity B: "I Wonder..." Hydrogel Cyrstals and Scientist Mystery Boxes:	30–40 minutes
Activity C: What is an Engineer?:	8–10 minutes
Reflection on Module 1:	5–10 minutes
Total Lesson Time:	60–80 minutes

Activity A: What is a Scientist?

MATERIALS FOR ACTIVITY A

- ☐ Book: *What is a Scientist?* (Barbara Lehn, 1998)
- ☐ Flip chart paper and markers

OPENING QUESTIONS AND PROMPTS

- Lead a discussion with the children using the questions below. Use flip chart paper to draw or write the children's ideas.

2 SciGirls
Girls are motivated by projects they find personally relevant and meaningful.

- Have each child draw a scientist. After drawing, they can share pictures with each other. 2

Facilitator Tip
Save these drawings for a later activity and for outcome assessment.

Science Journals
Drawings can be included in children's Science Journal

6 SciGirls
Girls gain confidence and trust their own reasoning when encouraged to think critically.

- Prompt the youth to think about what scientists are. 6
  Some example questions might include:
  - What do we know, or think we know, about scientists?
  - What are things that scientists do?
  - Where do they do their work?

PROCEDURE (EXPERIENCING)

- Read the book, *What is a Scientist?*

SHARE/PROCESS/GENERALIZE: ACTIVITY A

2 SciGirls
Girls are motivated by projects they find personally relevant and meaningful.

- After reading the book, lead youth in a discussion about how they can and do act like scientists. Examples of prompts are: 2
  - **Which activities in the book looked interesting to you?** Try to encourage youth to identify what ideas interest them and why.
  - **Have you ever done something like these children are doing?** This is important to help children identify how they have acted like scientists in their own lives.
  - **What could we add to our charts from earlier about what we know about scientists?** Add any items that children mention, especially as related to something they heard from the book or other ideas the book may have sparked.

Using Math
Note the "Use math to count or graph" item if the children do not mention this one.

  - **Can children be scientists? Tell about a time when you were a scientist.** The goal here is to have youth identify themselves as "scientists" or capable of being scientists. Some youth may not realize that things they do everyday are the same things scientists do on a daily basis.

Activity B: "I Wonder..." Hyrdogel Cyrstals and Scientist Mystery Boxes

PART ONE — "I WONDER" BOARDS AND HYDROGELS *(see page 9 for alternate activity)*

This activity introduces the children to the **"I Wonder" Board** and the idea of wondering out loud about our curiosities. It uses colorful "hydrogel crystals" to help children practice observing and asking questions. Children explore Mystery Boxes to practice these important skills of scientists.

MATERIALS FOR ACTIVITY B: PART ONE

- ☐ Hydrated hydrogel crystals
- ☐ Small cups or bowls, 1 for each pair
- ☐ Paper towels
- ☐ Flip chart paper (for the "I Wonder" Board)
- ☐ Markers

GETTING READY

- Divide the students into pairs.
- Put a small amount of hydrated crystals on each plate/in each cup (1 cup per pair).

OPENING QUESTIONS AND PROMPTS

- Lead a discussion with the children using the questions below. Use flip chart paper to draw or write words that answer the questions:
    - What is a "sense"?
    - Can we name some senses?
    - What senses did the children in the book use to learn about things?
    - How else can we use our senses to learn about something? 6

6 SciGirls
Girls gain confidence and trust their own reasoning when encouraged to think critically.

PROCEDURE (EXPERIENCING)

- Lead the children through identifying the senses: sight, smell, touch, taste, and hear. Explain that in this activity **we will not use the sense of taste.**
- Ask youth to remember the book we just read and how scientists use their senses to observe. Challenge children to act like scientists in this activity and explore using their senses.
- Share a small container of hydrogels with each group. Remind children to not use the sense of taste for this activity. Have youth take a few minutes to explore and observe using their other senses. In this free exploration try not to respond to any questions yet, instead wonder out loud with the children. 3

3 SciGirls
Girls enjoy hands-on, open-ended projects and investigations.

Science Journals
Have children take a few minutes to write or draw what they see, hear, touch, or smell in their Science Journal.

SHARE/PROCESS/GENERALIZE: ACTIVITY B PART ONE

- After free exploration, bring youth together and explain how to capture their wonderings onto a tool called an "I Wonder" Board.

"I Wonder" Board
On the board, collect the children's thoughts using words or drawings. Children can print their own thoughts on sticky notes to put on a larger board, write directly on the board, or have an adult write for them.

- Examples of prompts adults can use are:
  - **What did you see?** This includes colors, shapes, sizes.
  - **Did anyone touch the crystals?** Observations can include that the crystals were squishy, soft, cold, or bouncy.
  - **Did you notice a smell?** Children may have noticed a smell or noticed there was no smell.
  - **Did you hear anything?** Youth may describe the sound the crystals made when bounced or report that the crystals did not make a sound in the container.

Using Math
You can have children raise their hands if they agree with someone else's statement to make a count of the observations.

ALTERNATE ACTIVITY IF HYDROGELS CANNOT BE OBTAINED

Go outside and take an "I Wonder" walk. In pairs, explore the yard and use your skills of observation to notice things, and share what you wonder about with your partner. Lead the group outside and model your own wonder about something you see. Then follow the "Share, Generalize, Process" procedure on page 8.

PART TWO — SCIENTIST MYSTERY BOXES

MATERIALS FOR ACTIVITY B: PART TWO

- ☐ Flip chart paper
- ☐ Markers
- ☐ Mystery Boxes *(see page 3 for details on MB preparation)*

GETTING READY

- Depending on the size of group, the leader may choose to engage with the boxes as a full group (e.g. 6 or fewer children in your group) or divide into 3 groups of no more than 3 children and have each small group investigate one box then share what they discover. You might also have the groups "rotate" around to experience each box. With a larger group, you may want to prepare more than 3 Mystery Boxes.

OPENING QUESTIONS AND PROMPTS

- Lead a discussion with the children to introduce the Mystery Boxes. Remind students that scientists use their senses to observe, and the students will be acting like scientists.
- Have youth think of how they can use their senses to explore the Mystery Boxes. You might need to revisit the 5 senses with the children (sight, smell, touch, taste, and hear). Remind students that we will not be using the sense of taste in this activity.

PROCEDURE (EXPERIENCING)

- Have youth start with an **unopened box** and guide youth through their observations. Ask what they hear, see, smell, or feel.

"I Wonder" Board
You may record their observations or other "wonders" about the boxes.

Facilitator Tip
You may need to probe further if any of their observations are not truly things they observed with their senses. Children might make assumptions or guesses based on evidence and their own reasoning.

- If time allows, you might have children close their eyes and use their sense of touch to feel the objects inside the Mystery Box. Ask again what observations they made with the sense of touch.

SHARE/PROCESS/GENERALIZE: ACTIVITY B PART TWO

- Talk about the difference between things **we can know for sure** compared to things **we might believe or guess**.
- Unwrap and unveil the objects and note any new observations the children make.
- Have children reflect on what scientist skills they used. Examples of prompts include:
    - **What senses did you use?** This might include touch, sight, or hear.
    - **What questions did you have when you were exploring? What did you wonder about?** Children may have heard something rolling around and wonder if that was a ball or other similar object. They may have wondered how many items were in the boxes.
    - **What guesses did you make? Were they correct?** Youth may have thought objects were a specific item and could have been correct/not so correct.

Facilitator Tip
Give an example if needed: Have you ever smelled something you thought would taste bad, but when you tasted it, you found it was really good? Or maybe the opposite, smelled good but tasted bad?

Activity C: What is an Engineer?

MATERIALS FOR ACTIVITY C

- ☐ Book: *Design. Invent. Create.* (Engineering for Everyone, 2014)
- ☐ Flip chart paper and markers

OPENING QUESTIONS AND PROMPTS

- Lead a discussion with the children using the questions below. Use flip chart paper to draw or write words that answer the questions below.
    - Have you ever solved a problem by fixing something or making something? Tell me about that.
    - Hold up an example of something that was designed/engineered (e.g. crayons, legos, a toy, a chair). Describe how you wonder about how the person who helps create this item figures out how to make it, how they test it to see if its strong enough, etc. Ask the youth if there is something that they've always wondered, "Who makes this thing?"
    - Explain that through this book, we're going to find out about people who help make things to solve problems or to create something (a product) that is needed.

PROCEDURE (EXPERIENCING)

- Introduce the book, *Design. Invent. Create.*, and read it out loud. Children might know someone who has an engineer job similar to one described in the book, so allow time to share.

Facilitator Tip
With a young audience, you may want to choose just a few of the different engineer jobs described in this book, rather than reading the entire book.

SHARE/PROCESS/GENERALIZE: ACTIVITY C

- Lead the children in a discussion about the skills they use that scientists/engineers also use. Examples of questions you can use include:

  - **Do you think engineers and scientists use the same skills? Which ones?** Engineers and scientists both make observations about the world. 6
  - **What seems different about what a scientist does and what an engineer does?** Many scientists learn more about a process in the world. Engineers often design solutions to problems.
  - **How have you acted like an engineer? What did you build or do?**
  - **Did you ever try to engineer something and it didn't work as planned?** It is important for children to know that it's okay to fail at first and this is part of the process of science and engineering!

6 SciGirls
Girls gain confidence and trust their own reasoning when encouraged to think critically.

Facilitator Tip
Adults might tell a short story of their own experience where they tried to create/solve a problem but it did not work the first time.

Wrap Up

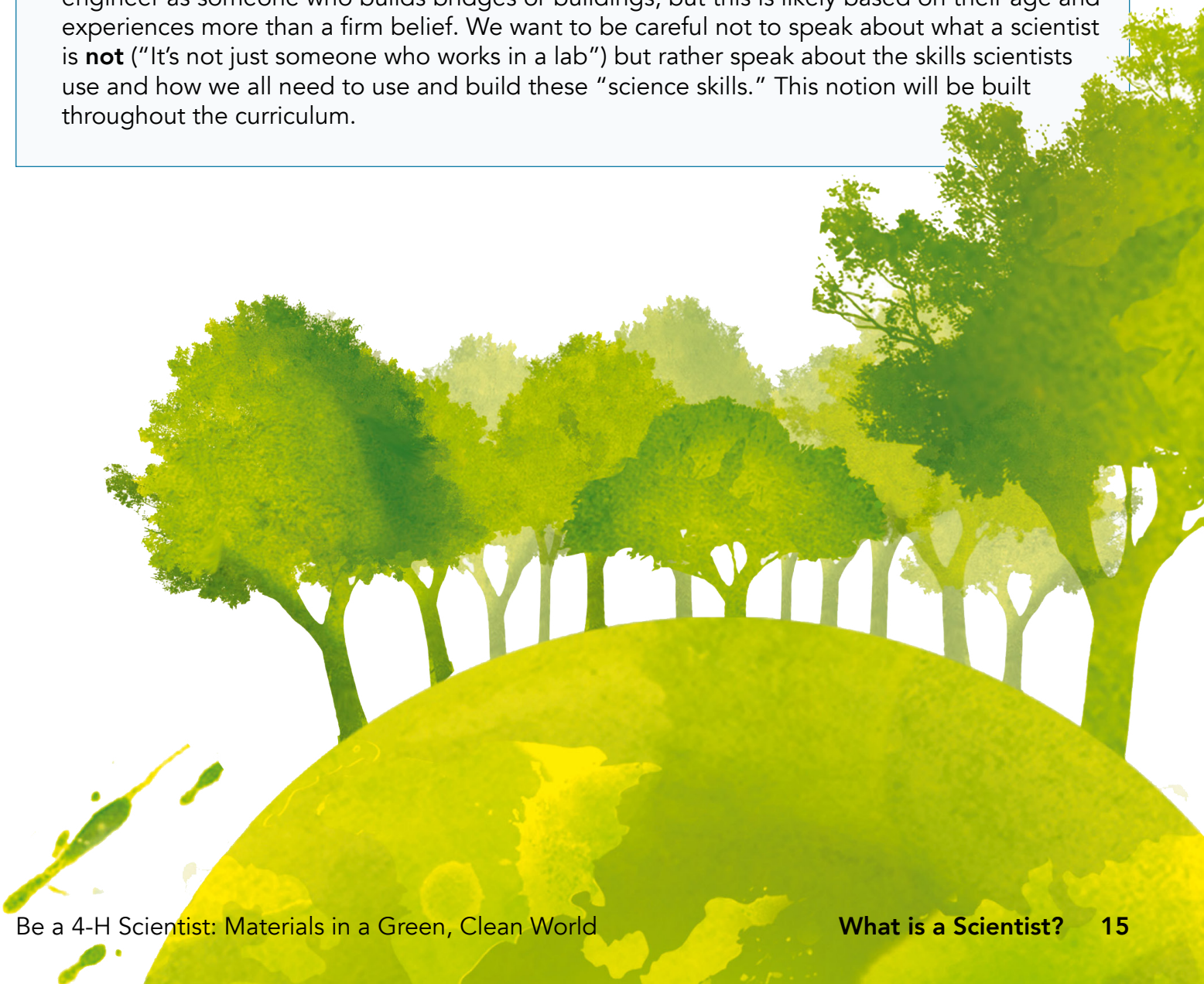
ENSURE CONCEPT UNDERSTANDING

Concept and Term Discovery

Help ensure that children understand scientists and engineers are people who use curiosity and questioning to explore the natural or "designed" world and to solve problems. There are many skills and processes that scientists and engineers use, such as asking questions, observing, collecting data, sharing what they discover, etc. We all use many of these skills every day! There are many careers and jobs that involve science and engineering design.

Common misconceptions often occur around:

Children may have a limited concept of a scientist as someone who works in a lab, or an engineer as someone who builds bridges or buildings, but this is likely based on their age and experiences more than a firm belief. We want to be careful not to speak about what a scientist is **not** ("It's not just someone who works in a lab") but rather speak about the skills scientists use and how we all need to use and build these "science skills." This notion will be built throughout the curriculum.



REFLECTION

Reflecting on experience is an essential part of learning and "making meaning of" an experience. Now is an opportunity to bring the children together and discuss the things they experienced throughout the module.

Facilitator Tip: *Circle Share*
You may want to use a "circle share" process to facilitate this discussion. Have children sit in a circle with you. Use a soft tossable object, such as a small toy as a "talking stick" object. Model to the children that you will ask a question, give them time to think quietly, then give your response while holding the "talking stick." You then gently toss the object to the next person for their turn to share. If you prefer, simply pass the object around the circle in order, eliminating the "toss" aspect.

- To quickly review some of the key points from the module, begin by holding up the books or boxes or point to the "I Wonder" Board to trigger memories. Examples of key points from the module include:
    - In the book *What is a Scientist?*, we saw children being scientists and heard about skills scientists use. We also read about different kinds of engineers in *Design. Invent. Create.* and how they are creative, clever problem solvers.
    - We used our senses to explore hydrogel crystals.
    - We got to explore Mystery Boxes with our senses.
    - We created our "I Wonder" Board:

"I Wonder" Board
Refer to your wonder board for this module — what questions did you explore the answers to? What questions do you still have?

    - Discuss other things you did with the group if desired.
    - Let the children know that they each did some of the things that scientists do!
- Some general reflection questions you can ask the children include:
    - What is something new you learned in this module?
    - Did you try something that you've never done before?
    - How were you a scientist or engineer today?
    - What questions did we explore the answers to? What questions do we still have?

SCIENCE NOTEBOOKS

Science Journals
You may want to have children redraw a scientist based on what they now know after completing the activities. Additionally, children can add additional observations or thoughts. You might also ask them to draw a picture of something they wondered about.

SCIENCE & ENGINEERING IN EVERYDAY LIFE — CONCEPT APPLICATION

When engaging youth in inquiry-based learning, hands-on activities serve as vehicles for learning new concept knowledge and skills; however, it is the application of new knowledge or skills to independent, real-world situations that is the critical factor in the learning process. Thus, to complete the cycle of experiential learning it is important to intentionally provide youth specific opportunities for authentic applications.

The **Science At Home** activities are possible extension activities that can be used with your group as time/interest allows. You might also look to your "I Wonder" Board for questions you'd like to explore further. If you meet multiple times, you might invite children to do a take home activity or investigate an "I Wonder," and have them report back or bring in an item as described. This helps support application of the concepts you've explored in this module.

SCIENCE AT HOME ACTIVITY

Science At Home is a handout for you to copy and send home with the children. The handout gives a brief summary of the module and provides several activity ideas. It encourages families to engage in science learning together, supporting application of the concepts. Make one copy per child, or you may email the activity if you prefer.

FEEDBACK

We encourage instructors to collect feedback throughout this module and submit via this evaluation form: 4hpolymers.org/evaluation

science at home

Be a 4-H Scientist!

Hello Families,

Your child is exploring science and engineering in the Be a 4-H Scientist! program. This week we discovered things that scientists and engineers do and we did some of those things too! We hope you will try one or more of these "Science at Home" activities with your child. This supports your child in practicing the skills and engaging in discovery! We hope your child will tell us what you did at our next session! Thank you!

Try these "Science at Home" Activities:

- Ask your child about creating an "I Wonder" Board. We use this to capture the things we are curious about. Families can create an "I Wonder" Board using a large sheet of paper or tag board—write "I wonder…" at the top, then all family members are encouraged to write their "I wonders…" on it. Your child and an adult or older teen can decide to explore or investigate one or more of their wonders.
- **Use Your Senses!** Child or family members close their eyes and take 3 minutes to use their senses to identify things they can smell, hear, or feel.
- **Guess the Smell:** Find a few different items in your home that have a scent or a smell. Examples could include: bar of soap, shampoo, vanilla extract, a pickle, a lemon or lime, other foods, freshly washed towel, dirty sock, etc. Have your child close their eyes (or use a hat pulled over their eyes as a blindfold) and have them smell the item. See how many they can identify! Switch roles using other objects and see how many the adult can identify!
- **Build a notecard bridge:** using two stacks of books to create a "valley", children and families can try to build a bridge using seven index cards (you can use scissors to alter the shape of the index cards, but no glue or tape!). See how many pennies your bridge can hold up before breaking!

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