NATIONAL
PEER REVIEWED

MODULE
1
GRADES 3-5

Sustainable Polymers

Plastics of the Future for a Green, Clean World

A 4-H STEM Curriculum for Grades 3-5 | 4hpolymers.org

National Science Foundation

NSF Center for Sustainable Polymers

Tips and Callouts

"I Wonder" Boards

These boards should be used to track children's questions and ideas during the lesson for further investigation. This tool promotes experimental 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 is 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.

Science and Engineering Practices

The Next Generation Science Standards (NGSS) identifies eight practices of science and engineering that are essential for all students to learn. Using these practices, youth make sense of phenomena and use these skills to investigate the world and design and build systems.

SciGirls

SciGirls Strategies

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

4-H Polymer Science Curriculum for

Grades 3-5

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" and the Science and Engineering Practices, as well as opportunities to use "I Wonder" Boards, science journals, and math. In addition, these modules incorporate the SciGirls Strategies for gender equitable STEM learning. We encourage instructors to collect feedback throughout this module and submit via this evaluation form: 4hpolymers.org/evaluation.

Module 1

Be a Scientist!

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If you are new to the 4-H polymer science curriculum and the youth you are working with have not participated in the "Be a 4-H Scientist! Materials for a Green, Clean World" curriculum for grades K-2, you may want to check out the K-2 curriculum at www.4hpolymers.org for background information or activities to support the learning objectives of this curriculum for grades 3-5

Introduction

MODULE SUMMARY

Youth will explore materials and their properties. Youth first consider what they think a scientist looks like and does, using the Draw-A-Scientist assessment. In activity A, youth use the practices of science and engineering as they sort and classify objects based on **properties**. **Properties** are characteristics that can be observed or measured; properties include size, shape, density, texture, hardness, color, and other ways something looks and feels. In activity B, youth will use criteria, standards by which something can be judged or decided, as they test slime materials and create their own improved slime.

Total lesson time needed for Module 1: 75-105 minutes not including set up time
Getting Ready: 35-60 minutes total

- Activity A: Draw a Scientist or Engineer (10-15 minutes)
- Activity B: What's my Property? (10-15 minutes)
- Activity C: Be a Slime Scientist (45-60 minutes)
- Reflection/Wrap Up (10-15 minutes)

Module Focus

LEARNING OBJECTIVES	• Youth will increase their interest in science and engineering • Youth will discover the work of a specific plastics or sustainability scientist/engineer • Youth will practice skills used by scientists and engineers
SCIENCE & ENGINEERING PRACTICES *Youth will engage in the following NGSS Practices:*	• Asking questions and defining problems • Obtaining, evaluating, and communicating information • Constructing explanations and designing solutions • Planning and carrying out investigations • Analyzing and interpreting data • Using mathematical and computational thinking
CONCEPTS & VOCABULARY	• **Criteria**: standards by which something can be judged or decided • **Engineer**: a person who uses creativity and a systematic approach to solving problems in ways that make peoples' lives easier and better • **Polymer**: large molecule made from chains of small repeating units. Each repeating unit is called a monomer • **Properties**: characteristics that can be observed or measured; properties include size, shape, density, texture, hardness, color, odor, and other ways something looks or feels • **Scientist**: a person who studies, specializes in, or investigates a field of science and does scientific work

Facilitator Preparation

ACTIVITY A

- ☐ Drawing paper - 1 sheet per youth
- ☐ Drawing supplies (pencils, pens, markers, crayons, etc)
- ☐ Flip chart paper - 2 sheets
- ☐ Marker (for facilitator) - 1
- ☐ Optional: Book: Ada Twist, Scientist (by Andrea Beaty) or Me, Jane (by Patrick McDonnell)

GETTING READY (5 MINUTES)

- Gather all supplies listed under Materials List

ACTIVITY B

- ☐ Bags of 15-20 random objects of various properties, (1 bag per small group) such as:
- Metal objects (e.g. paperclips, coins, keys)
- Glass objects (e.g. marbles, craft stones, small bottle)
- Plastic objects (e.g. containers, toys, hair clips)
- Wood (e.g. pencil, craft sticks)
- Fabric or soft objects (e.g. bandana, felt, cotton ball, toys)
- Other misc. objects

GETTING READY (10-20 MINUTES)

- Prepare bags of objects: 1 bag for each group of 3-4 youth. Each bag should contain 15-20 random objects which have a variety of properties, (metal, wood, glass, plastic, and fabric).
- Plan a method to divide youth into smaller groups of 3-4.

Facilitator Preparation (Continued)

MATERIALS - ACTIVITY B

Technology equipment to play Meet a Scientist video (i.e. laptop/tv, cables, internet connection, etc). Choose one at SciGirls:

3M Chemist: (4 min) http://www.scigirlsconnect.org/resources/chemist-bridgette-shannon/

Toy Engineer (2:06 min) http://www.scigirlsconnect.org/resources/toyologist-katie-broughton/

Robotic Scientist (2:37 min) http://www.scigirlsconnect.org/resources/robotic-soccer-scientist-manuela-veloso/

Scientist Story (Appendix A) if video/internet is not available -1 copy

MATERIALS - ACTIVITY C PART 1 (CONTINUED ON NEXT PAGE)

- ☐ 1 box borax powder, such as 20 Mule Team Borax (available in the laundry detergent aisle)
- ☐ Non-toxic white school glue (PVA) (washable)
- ☐ Baking Soda (you will need less than ½ cup for a group of 25)
- ☐ Contact lens (saline) solution-must indicate boric acid in the ingredients list (any cheap brand works fine) - 1-2 bottles depending on size of group
- ☐ Water
- ☐ Food coloring (optional)
- ☐ Stirrers (e.g. spoons or craft sticks)

GETTING READY (20-40 MINUTES)

Facilitator Tip
If your activity time is limited, you may choose to make slime ahead of the session, and have youth analyze the slime you have pre-made. Then focus your time for Activity B on youth creating their "different" slime from the provided ingredients.

Gather supplies and set up a work space for making slime.

- ☐ Make copies of Appendix B, C, & D - (B & C may be copied back-to-back).
- ☐ Consider how you will divide your group into pairs.
- ☐ In Part 1, youth will work in pairs to make slime according to directions, then analyze it. 5

Continued on next page

Facilitator Preparation (Continued)

- ☐ Measuring spoons -1 tablespoon and 1 teaspoon
- ☐ Small container with a lid OR small cups
- ☐ Plastic cups
- ☐ Slime Recipe Part 1 (Appendix B) - 1 copy per pair, OR print on chart paper or whiteboard for whole group
- ☐ Slime Test Observations Sheet, 1 copy for each pair (see Appendix C) or create for your group on chart paper
- ☐ Paper towels
- ☐ Sandwich bags (2 per youth for slime)
- ☐ Flip Chart paper - 1 sheet

PART 2

- ☐ Better Slime recipe template (Appendix D) - 1 per pair

For Activity C-Part 2, you will need to provide **several options** in addition to those listed above, which youth can choose from to make their new slime:

- ☐ **Glues**: washable, clear glue or colored clear glue, colored opaque glue, glue with glitter, or purchase PVA from a science supply store
- ☐ **PVA Activators (cross-linkers)**: Borax (use in crystal form, use in solution form), saline solution (contact lens solution--must list boric acid in its ingredients)
- ☐ **Beauty/Texture options**: food coloring, acrylic paint, glitter, tiny beads, white shaving cream (foam, not gel!), scented lotion

- ☐ In Part 2, youth may work in pairs or individually and create a "different slime," having choices as to what supplies to use. Set up work stations that allow for youth to easily access supplies and create their new slime recipes. Facilitators will need to determine which optional supplies you wish to provide.
- ☐ Ensure access to running water for cleanup

5 SciGirls

STEM is collaborative, social, and community-oriented

Background Information for the Facilitator
The things youth do in their daily lives are often similar to the work of **scientists** and **engineers**, although they may not realize it! Youth will often visualize these adults as wearing lab coats, building bridges, and using specialized tools. However, youth naturally use scientific and engineering concepts as they explore and change their world through design and play. The goal of this module is to help young people identify how their actions can reflect the work of scientists and engineers. The activities will help guide youth to a fuller understanding of what scientists and engineers do, the "practices" of science and engineering.

Science and Engineering
Explain that scientists and engineers would do an experiment or redesign their plan more than once.

Additionally, the activities will help reinforce the idea that all of us use the skills associated with science and engineering in our everyday lives. In this module, we have highlighted most of the eight Science and Engineering Practices (Next Generation Science Standards) to support facilitators in introducing these Practices to youth and building this foundation for understanding. Create or utilize a poster of the 8 Practices of Science and Engineering. In each of the subsequent modules, youth will engage in two or three of the Practices. Facilitators are encouraged to continually guide youth to see themselves engaging in the Practices.

"I Wonder Board"
While the professional science and engineering communities often require specialized training and tools, anyone can learn to engage in similar processes and practices! Activities encourage "wondering" and emphasize how important it is for adults to model and encourage curiosity in youth. These "wonders" are often turned into questions that can be investigated or studied. Consider posting an "I Wonder" board (see Front Matter for full explanation) to help surface these "wonders" and perhaps provide inspiration for your group to dig deeper into their curiosities.

Background on Slime
The glue (partially hydrolyzed poly(vinyl acetate) or PVA) has long flexible chains of molecules in it; these chains are **polymers**.

Borax dissolved in water forms an ion called a borate ion. When the borax solution is added to the glue solution, the borate ions help link the long polymer molecules to each other so they cannot move and flow as easily (cross-linking of the polymers). When enough polymer molecules get connected together in the right way, the glue solution changes from a liquid to a rubbery substance.

- Water is an important ingredient in slime. Water helps the polymer molecules slide past each other so that the slime can flow. If you let the water evaporate, your slime will end up like a solid piece of plastic.
- See the Extension activities at the end of this module for an art project idea to add to this lesson which explains how to dry sheets of slime.

Activity A

Draw a Scientist or Engineer (10-15 minutes)

Youth will consider what they think a scientist or engineer looks like or does. It also helps the facilitator gain an understanding of the perceptions or misconceptions youth have about scientists and engineers. Few people are aware of all the different branches of science and engineering. This activity may be used as an assessment, by repeating the drawing after module six, to compare young people's perceptions of scientists and engineers after participating in all six modules. 4

OPENING QUESTIONS AND PROMPTS

Ask youth to close their eyes and imagine a scientist or an engineer at work.

Science Journals
Drawings can be included in the Science journal.

PROCEDURE (EXPERIENCING)

1. Pass out paper and writing utensils/markers to every youth.
2. As youth are imagining (silently), a further prompt could be: "What do you know, or think you know, about scientists (or engineers)?"
3. Allow 1-2 minutes for youth to think in silence. On their sheet of paper, ask youth to sketch what they imagined and any ideas they have about what a scientist (or engineer) does or looks like when they are working. Allow youth to draw for 5 to 8 minutes.

4 SciGirls

Identify and challenge STEM stereotypes

SHARE/PROCESS/GENERALIZE:

After drawing, have youth share their pictures and ideas as you make a word web or a list. Keep this for future sessions so that youth can keep adding how their thinking is changing and expanding. These visuals will be a youth created definition of "scientist" and "engineer." Ideally youth can add to it independently at arrival or departure time.

- Ask youth to describe similarities and differences between what people drew.
- Explain that in our next activity, we will use a skill that both scientists and engineers use, which is using our senses to make observations.

Facilitator Tip
See Front Matter: Draw A Scientist Test, for further explanation.
Save these drawings for a later activity and for outcome assessment purposes.

Activity B

What's My Property? (10-15 minutes)

Youth discover different properties as they sort and classify objects, building a foundation for understanding how the properties of materials and matter influence its purpose. Youth also meet a scientist 4 who is using chemistry to study and make materials, and hear about some of the challenges and rewards of being a scientist.

OPENING QUESTIONS AND PROMPTS

Facilitate a group discussion to get youth thinking about what they know about the main learning objectives of the module. You may ask the following prompts. There is overlap in some questions between modules so you may want to develop new broad, open-ended questions for your group, if needed.

- Describe some of the **properties** of objects around you.
- Explain how you think scientists use the term property.

Facilitator Tip
Youth may think of land, or something one "owns." Youth may also understand **property** to describe a characteristic of something, such as soft or hard. You can tie these definitions to each other because, in a sense, an object does "own" its property.

4 SciGirls

Identify and challenge STEM stereotypes

PROCEDURE (EXPERIENCING):

1. Divide youth into pairs. 5 Explain that partners will work together to find an object in the room that fits the description of a property, given by the facilitator. For example, for the property "soft," youth should find an example of an object that is soft. Additional examples could include: waterproof, brittle, strong, absorbent, clear, opaque, shiny, and rough. (If needed, you can brainstorm properties youth know, such as clear, shiny, transparent, bendy, etc. in the opening question.)
2. Play "Can You Find It?" for approximately five minutes, and address any differences of opinion by asking further questions of the youth. You might invite several pairs of youth to explain their differing opinions to the whole group (e.g. "Your team thinks this cup is hard. What is your reasoning or evidence? Your group disagrees that this cup is hard; what evidence do you use to show it isn't hard?")

Facilitator Tip
You can add in the vocabulary word "**criteria**" at this point if the youth have not yet used the term. You might ask the youth "What makes a friend a great friend?" Explain that they have identified "criteria" for what makes a good friend and that "criteria" are standards by which something can be judged or decided. You can return to an example from this activity to highlight how criteria for a property can vary based on the uses of the object and needs of the user.

3. Continue to introduce or help define "properties" words as youth hunt for or explain what they found.
4. Explain to youth that their next challenge is to identify properties of different materials. This game is called "What's My Property?" Pairs can combine into small groups of 4 students.
    - Each group needs a bag of about 15 objects that includes different materials and has different properties.

5 SciGirls

STEM is collaborative, social, and community-oriented

- Ask each group to determine the person whose birthday is closest to today's date. This person will serve as the first "leader." The role of the "leader" will change with each round so that every youth has the opportunity to fill this role.
- The leader should think of one specific property (without saying aloud) and separate the objects into two piles: one pile of items that have the property and one pile of items that do not. The other youth should then figure out what the property might be.
- If group members suggest a property that the leader did not originally intend, the leader can respond, "That's a good one but not the one I'm thinking of." The group should continue guessing. To avoid excessive frustration, the leader may give hints as necessary.
- After leading one example of the game, have youth switch roles, giving each person at least one turn at being the "leader".

SHARE/PROCESS/GENERALIZE:

Help guide youth as they question, share, and compare their observations. You may choose one of the questions below as a prompt. If necessary, use more targeted questions as prompts to get to particular points. Remember these questions are not about getting one right answer. 3

- Describe the properties you guessed during the activity.
- Tell us about properties you found challenging to identify.

Facilitator Tip
Youth may include that hard or soft are properties that vary a great deal, for example a plastic cup is hard but can be flexible. A tennis ball is hard but has a soft, fuzzy cover. It is important to help youth consider how our descriptive words can be very essential.

- Describe if and why your group disagreed about a property.
- Explain the reasons why it might be difficult to identify a specific property. 3

Youth may realize that properties can exist to differing levels or degrees. For example, that hardness varies, that absorbent can describe something that is more or less absorbent than something else, such as a piece of cloth vs. a paper towel vs. a sponge.

Introduce the I Wonder Board to the group
Explain that there are practices that scientists and engineers use as they think and work.

One of those practices is to ask questions and define problems. (The facilitator would start the list of science and engineering practices here) We want to capture our wonderings and questions onto a tool called an "I Wonder" board (large flip chart paper or poster board with the words "I Wonder…" across the top).

On the board, collect the young people's questions or wonderings. Youth 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 were you curious about as we did this activity?
- What did you wonder about?
- What questions did you have about the objects?

To help build understanding of application in real-world settings, show the short video from a scientist (see materials list). This scientist will describe what they do, what they are curious about, and how they carry out investigations in the lab or in their research.

Meet a Scientist! 6 Use the Scientist Story (Appendix A) by reading it aloud with the group, or making copies and having youth read it aloud.

Use the questions below to engage youth in a discussion:

Show 4-5 minute video.
Alternate activity: if no internet connection is available.
One of the science and engineering practices is to ask questions and define problems. 2

2 SciGirls
Support as they investigate using STEM practices

6 SciGirls
Interact and learn from diverse STEM role models

- What is the problem this scientist identified? (After this question is answered, note that one of the science and engineering practices is to ask questions and define problems. Add 'Asking questions and defining problems' to science and engineering practices list or note it on the poster).
- What are some of the ways the scientist conducts an investigation? (You will return to these after Activity C, so you will want to write them on chart paper or a whiteboard).
- What are some challenges scientists face?
- What did you hear about why this person enjoys being a scientist?

Activity C

Be a Slime Scientist (45-60 minutes)

In Part 1, youth engage in the practices of science and engineering by creating slime and then analyzing its characteristics. Note: If there are time constraints for your group, an alternate approach is for the facilitator to pre-make a batch of slime for Part 1.
In Part 2, youth create a different slime, using their data and a choice of ingredients to create a slime to their specifications.

Facilitator Tip
If possible, do not reveal to youth that they will create a different slime. You might instead explain that after analyzing characteristics, the youth will receive a challenge as a "slime scientist."

OPENING QUESTIONS/POSSIBLE PROMPTS

Facilitate a group discussion to get youth thinking about what they know about the main learning objectives of the module. You may ask the following prompts.

- What comes to mind when you hear the word experiment. (Prompts: Where do they occur? Who does them?)
- Describe any experiences you have had with doing an experiment.

PROCEDURE (EXPERIENCING):

PART 1

1. Connect the word 'experiment' to 'investigation' Explain that as scientists and engineers ask questions and define problems, they then plan and carry out investigations. Explain to youth that their task is to investigate slime. Gather background knowledge youth have about slime and if they have ever created it before.

   Youth must conduct tests to determine what properties slime has.

2. Divide youth into pairs. Pairs will follow the recipe for slime (Appendix B) to create their batch of slime. 5

Facilitator Tip
If desired, the facilitator could make the borax solution for the whole group ahead of time.

3. Youth will conduct slime tests using the Slime Test Observation Sheet (Appendix C) or a similar chart created on chart paper/white board. Explain that obtaining information is a science and engineering practice (add to list or point out on the 8 Practices of Science and Engineering poster). 2 Each pair should conduct each test and record their observations. This offers practice in acting like scientists, as scientists must make observations using their senses (not taste!). Scientists and engineers communicate information to others from their investigations so recording information (data) is an essential element.

Science and Engineering
Obtaining and Communicating Information to list or point out on the 8 Practices of Science and Engineering poster).

Facilitator Tip
While most of the slime observations will be similar amongst your group, practicing this skill is important for the next activity, in which youth will create a unique recipe and conduct their tests on different types of slime. Collecting and recording data will be important in order to share their results with the rest of the group, and to analyze similarities and differences based on the "recipe" used.

4. Bring the whole group back together to discuss the slime creation and tests. Use these questions as a guide:
   - What did you observe as you went through the different steps of creating your slime?
   - What challenges, if any, did you encounter?

5 SciGirls
STEM is collaborative, social, and community-oriented

2 SciGirls
Support as they investigate using STEM practices

- Explain how well your slime turned out. What criteria are you using? Explain what happened or why you think it did or didn't.
- Looking at the data you collected on your slime test observation sheet, what did you learn? Do you think you could change slime?

Facilitator Tip
Try to guide students to connect that if they changed the recipe, they could possibly change the results of their tests. Guide them to inquire if they want a desired effect, what could they do to cause that effect? (To invite inquiry based learning, ideally create a learning environment where the youth initiate making their own slime recipe and perceive it as "their idea.")

Science and Engineering
Explain that scientists and engineers would do an experiment or redesign their plan more than once.

5. This is part of the engineering design cycle that involves planning, testing, redesigning, and retesting. Scientists may also change a variable in their experiment to see what results. They change one variable at a time so they can determine if the change has an impact on the results. In Part 2, youth will be challenged to identify criteria for their own slime recipe.

Facilitator Tip
You may want to introduce the term "**polymer**" here, if you haven't yet talked about polymers. A polymer is a long chain molecule, similar to a string of beads or a string of paper clips. The key points to introduce are that the polymers in glue are our base for slime, water helps the slime flow, and the borax/contact lens solution serves to connect the long chains and hold your substance together (cross-links). Module 2 explores the concepts of molecules, polymers and cross-linkers more deeply.

PART 2

1. Challenge youth to create a new slime recipe using basic slime building blocks. Youth will need to consider what design criteria or specifications they would like to achieve (e.g. very stretchy, will hold the shape of a ball and bounce, colorful, soft, nice smell, etc). Ask youth to share how they might like to change their slime. Next, have youth write out their criteria and recipe, using the A Different Slime Recipe template handout (Appendix D) or a science journal before getting any materials. Pairs can have another pair of youth check their recipe to ensure they have included the key elements. Facilitators can also check recipes as necessary. As student pairs check in with the facilitator to show their recipe,

facilitators can ask youth to point out where they have used math during this process.

Introduce that the students have just used their mathematical measurement skills as they have changed their slime recipe.

Science and Engineering
One of the science and engineering practices is 'Using mathematical and computational thinking' which can now be added to the science and engineering practices list or noted on the poster).

2. Youth should create their recipe. If they find it is too sticky or too runny, the first technique to try is more kneading! Youth may also let their slime sit for 3-5 minutes then use their hands to warm and knead the slime. In addition, they can add ingredients and should note the change in their recipe (e.g. if the slime is too sticky after kneading, they may add ½ teaspoon borax solution or saline solution at a time until the slime is not sticky).
3. Once pairs are satisfied with their slime creation, they can start testing using the slime test observations sheet (Appendix C) or similar chart.

Facilitator Tip
The test results will vary greatly, depending on how many variables the youth changed in their recipes. These can be discussed and youth can show their slime as part of their evidence. Collecting and recording data is an important science skill and one way to give evidence when presenting your findings! Data helps youth analyze similarities and differences and to draw conclusions.

SHARE/PROCESS/GENERALIZE

Help guide youth as they question, share, and compare their observations. You may choose one of the questions below as a prompt. If necessary, use more targeted questions as prompts to get to particular points. Remember these questions are not about getting one right answer. 2

- Describe what you created in your experiment.

2 SciGirls
Support as they investigate using STEM practices

Facilitator Tip
To make this sharing process a little more active, you can invite the youth to think about what criteria they had for their slime, and respond to the following instructions:

- Stand up if you had a criteria to make a slime that was bouncy, like a super ball. Be prepared to describe what "bouncy" criteria means to you.
- Stand up if you had a criteria to make a slime that had a nice texture. Be prepared to define what "nice texture" criteria means to you.
- Ask if any youth had a different criteria, then ask youth to stand if they used that criteria. Stand up if you made a slime that didn't turn out exactly how you wanted it to. Ask these youth to talk about what their slime is like and what they wanted it to be like

- Describe the data you collected to test your slime.

Science and Engineering
Youth will likely be using the Practice of 'Analyzing and Interpreting Data' and 'Constructing Explanations' as they respond to these questions. Add these to the Practices poster or note them on the list.

- What happened as you made your "different slime"?
- What do you think was challenging about being a slime scientist? 3
- What do you think was rewarding or fun about being a slime scientist?

ENSURE CONCEPT UNDERSTANDING (10-15 MINUTES)

At this point, it is important to ensure that the terms **criteria, engineer, polymer, properties**, and **scientist** have been discovered by or introduced to the youth. The goal is to have the youth discover terms and concepts on their own, defining them with their own words. After youth have stated and shared their understanding of the concepts, then you may introduce the terminology used by scientists to refer to the concepts. Facilitate a brief conversation on the importance of the concepts.

3 SciGirls
Embrace struggle, overcome challenges, and increase self-confidence in STEM

SCIENCE & ENGINEERING IN EVERYDAY LIFE — CONCEPT APPLICATION

Facilitator Tip
When engaging youth in inquiry-based learning, hands-on activities serve as vehicles for learning new concepts, 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.

REFLECTION

Reflecting on experience is an essential part of learning and "making meaning of" an experience. Now is an opportunity to bring the youth together and discuss the things they experienced throughout the module. You may want to use a "circle share" process to facilitate this discussion. Have youth sit in a circle with you. Some general questions you can ask the youth include:

- Did you try something that you've never done before?
- What is something new you learned from the activities today?
- How were you a scientist or engineer today?
- Which of the eight practices of science and engineering did you use today?

EXTEND THE LEARNING

- **Science at Home** - These are possible extension activities that can be used with youth as time/interest allows. If you meet multiple times, you might invite youth to do a take home activity 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. These activities are also shared on the Science at Home handout.

Facilitator Tip
Science at Home can be copied and sent home with the youth, or emailed. It includes 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.

- **Service Learning in Action** - Planning and carrying out a service-learning project can be an exciting opportunity for youth to apply their learning as they work to address local and world needs. In Module 6: Service Learning, youth will dive deep into the experiential process by creating and carrying out a service project related to plastics. Below are some suggested activities and real-world service-learning examples that you can explore with your students related to plastics in our world.
- **Real-World Examples:**
  Kids Make Slime for a Cause - Sara Mckee and Elise Lutchman transformed their perfect slime recipe into a money making business to support a worthy cause. After developing different types of slime, Sara and Elise sold containers to fellow students and donated 100% of their profits to Habitat For Humanity. To read more about their story, please visit:

Habitat for Humanity Halton-Mississauga. (2017, July 10). *Getting Slime-y For a Good Cause.* https://habitathm.ca/single-post-2017-07-10-getting-slime-y-for-a-good-cause/

- **Turning Plastic Trash to Art** - Sean Connaughty has collected over 6,500 pounds of trash over 5 years from a Minneapolis lake. Not only does he create art from trash, (imagine McDonald's arches from straws), he shares the impact of this trash with the companies and consumers that produce the waste. Check out his story and ways you can make change happen at:

Ross, J. (2019). Lake Hiawatha's guardian artist uses sculptures to call attention to trash problem. *Star Tribune*. Retrieved February 21, 2020, from http://www.startribune.com/lake-hiawatha-s-guardian-artist-uses-sculptures-to-call-attention-to-trash-problem/559597982/

SERVICE IDEAS

- **Slime Business** - Put your sublime slime engineering skills to work by making slime to sell to friends and family. With slime profits, consider sponsoring an animal at your local zoo or nature center. You can also donate to organizations that help rehabilitate animals impacted by plastics.
- **Make A Plan** - Keep a plastic diary and list every piece of plastic that you touch in a day. Sort the plastics into two categories: plastics that can be used over and over again and plastics that are thrown away after one use. Make a plan on how you can reduce plastic items that are thrown away after just one use. Ask others to join your efforts. Read about the impact of plastic straws use here: https://www.washingtonpost.com/lifestyle/kidspost/plastic-straws-are-little-but-they-are-part-of-a-huge-problem/2018/09/07/63bfe44e-ac9f-11e8-b1da-ff7faa680710_story.html?noredirect=on
- **Informational Interview** - Interview a solid waste collector or school engineer and ask what are the most common plastics they see in the waste bin. Ask them for ideas to decrease the amount of plastics in the garbage. You can also conduct a waste audit - https://cleanriver.com/waste-audit-in-5-easy-steps/

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Science at Home

Be a Scientist: Module 1

Hello Families,

Your child is exploring science and engineering in
Sustainable Polymers: Plastics of the Future for a Green, Clean World.

This week in the **Be a Scientist** lesson, we learned what scientists do and how your child naturally uses scientific and engineering concepts as they explore and change their world through design and play. Your child then became a slime scientist as they tested slime materials using science and engineering skills. By using what they discovered, your child created their own improved slime to meet their specifications.

We hope you and your child will try one or more of these "Science at Home" activities. You get to have fun together making new discoveries while practicing science and engineering skills. Please ask your child to share what you did at our next session! Thank you!

Try these "Science at Home" Activities:

- Create your own slime at home. (You can find a variety of recipes and experiments at How To SMILE, a database of science, engineering and math activities created by science museums, at https://www.howtosmile.org/)
- Make different slime! https://littlebinsforlittlehands.com/homemade-slime-recipe/ has many slime adaptations using shaving cream, other add-ins to extend the experience.
- Learn about science careers: Watch a short video about a scientist or engineer who has a job that sounds interesting to you! Find videos about scientists and engineers at SciGirls http://www.scigirlsconnect.org/ or at Engineering-GoForIt! http://www.egfi-k12.org/engineer-your-path/on-the-job/on-the-job
- Create Slime Art: Dry thin sheets of colored slime into art. You will need 1-2 days drying time. Find directions at https://www.stevespanglerscience.com/lab/experiments/slime-art/

References:

Brabandere, S., & Science Buddies. (2017). Slime: Is It a Solid, Liquid--or Both? Retrieved from https://www.scientificamerican.com/article/slime-is-it-a-solid-liquid-or-both/

National Science Foundation

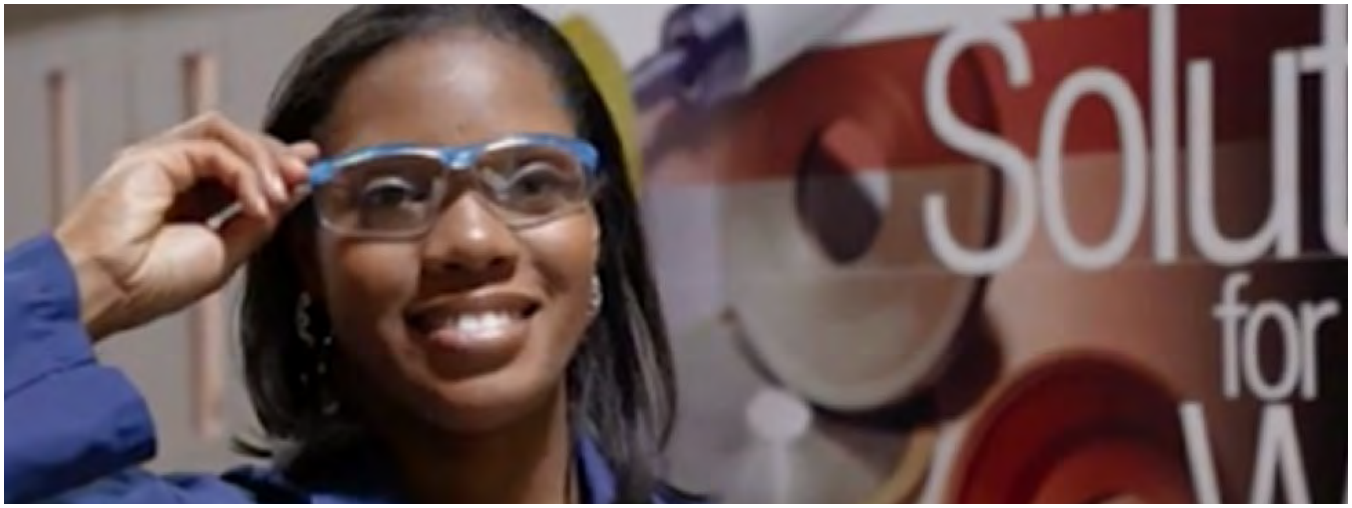
NSF Center for Sustainable Polymers

Appendix A

A SCIENTIST STORY: 3M CHEMIST BRIDGETTE SHANNON

http://www.scigirlsconnect.org/resources/chemist-bridgette-shannon/

Bridgette's formula for success is using her love of chemistry to develop groundbreaking products at work and create natural remedies for her family at home. She shares her story on PBS SciGirls.



Hi, my name is Bridgette Shannon and I am a product development specialist at 3M. I have a Bachelors in Chemistry and Ph.D. in inorganic chemistry and that is essentially everything on the periodic chart.

As a product development specialist in the 3M's Abrasive Systems Division, I work on developing the grain or mineral that goes into products like sandpaper or the grinding tools that does all the surfacing on metal and wood. This is the shaped ceramic grain, so this is an example of the types of minerals that I develop in the lab. We take the mineral and put it into a grinding wheel and we design this mineral for faster cutting, longer life time, so that they are more productive.

I love the fact that I turn an idea into an actual product that people can use in every day, so in a sense I am changing people lives.

I grew up in Little Rock Arkansas with my seven brothers. I am next to the youngest. I would say that I was a rough little girl, I tried to keep up with the boys and do what they did. I am very close with my family and what it taught me, as a woman, is to be there for one another and always make sure that we are there helping one another and that's why I like to help people today. And also, it taught me to stand up for myself because I had to stand up for myself being the only girl with those boys.

Appendix A
(Continued)

I first fell for Chemistry in high school when I had a really good chemistry teacher. She taught chemistry in a fun way. Chemistry is everything we do. You are able to make any product or build anything, It's everywhere. It is all around us and that was fascinating to me.
The best part of my job is being able to go to the Performance Test Center and determine whether or not the mineral I made is going to help make someone's life easier. The mineral that we made to do the cutting is actually designed for a faster and cooler cut, and that is exactly what you just saw here with the robot.

After I finished undergraduate school, I took a job working at L'Oreal manufacturing plant in their lipsticks division. I really loved working on makeup products, because it is something that I could use everyday, so it was cool. My husband is also a scientist who works for 3M. We have two boys: D.J. who's 11 and Jackson who's 3 and then we have one on the way.
One of the things I like to do in my spare time is make my own skincare products and today I am going to make a soothing ointment. My youngest is sick with a cold and so I want something that is calming, a light soothing ointment that helps him sleep at night.

I had a challenge of not being able to find things that I need on the shelf, so I decided to modify my own. And what I like best about that is that I can control what goes into it.

My advice to young girls would be first off, never give up. Sometimes things may seem hard, but everything takes time and secondly, build a support team. Surround yourself around positive people, people that are going to help you and uplift you and keep you encouraged to push forward.

Appendix B

SLIME Recipe-Part 1

Each pair will follow this recipe exactly for Part 1 of the activity:

Directions

1. Prepare Borax solution. If the Borax solution has already been prepared by your leader, begin with Step 2.
   - ☐ Measure ½ teaspoon of 20 Mule Team borax and pour it into the small container or cup.
   - ☐ Measure 2 tablespoons of water and add to the small container/cup.
   - ☐ Stir the borax and water well, for one minute, until all or most crystals dissolve. Set aside when done. Some of the borax crystals may not dissolve.
2. Pour 4 tablespoons (¼ c.) of glue into a new plastic cup.
3. Add 4 tablespoons (¼ c.) of water to glue and stir to mix well.
4. If you would like colored slime, add 2-3 drops of food coloring to the glue and water mixture and stir until mixed.
5. Continue stirring and slowly pour 2 tablespoons borax solution into the glue solution. Try to pour the borax solution all around the plastic cup, and leave any undissolved particles of borax in the small container.
6. Mix well. You will need to squeeze and knead the slime with your hands to make sure it's well mixed. You may want to scoop the slime onto a plate or piece of plastic/wax paper so it's easier to knead.

Caution:

Remember to keep your slime away from your eyes, and the carpet and furniture.
Wash your hands after working with your slime.

Appendix C

SLIME Tests Observation Sheet

Conduct each of the following tests. Observe what happens and record your observations in the blank boxes.

TEST	SLIME 1 OBSERVATIONS	SLIME 2 - "BETTER SLIME" OBSERVATIONS
DESCRIPTION (Color, texture, odor, other)		
SLOW POKE TEST (slowly poke one finger into the slime; repeat 3 times)		
QUICK POKE TEST (quickly poke one finger into the slime; repeat 3 times)		
SLOW PULL TEST (slowly pull on a piece of slime; repeat 3 times)		
QUICK PULL TEST (quickly pull on a piece of slime; repeat 3 times)		
BLOB TEST (let your slime sit for 2 minutes on a hard surface)		
BOUNCE TEST (roll your slime into a ball and drop on the table surface)		

Appendix D

Be a Scientist: A Different Slime!

Use the data you collected from your slime observation sheet to help you adjust the ingredients to fit your desired criteria.

Step 1: Determine the changes you want to make:

Step 2: Determine the criteria you want to achieve in your new slime recipe:

Texture:

- ☐ Very stretchy
- ☐ Will hold the shape of a ball and bounce
- ☐ Sticky
- ☐ Not sticky
- ☐ Easily molded
- ☐ Thick consistency
- ☐ Spreads like a liquid

Beauty:

- ☐ Colorful
- ☐ Soft
- ☐ Nice smell
- ☐ Other:

Step 3: Use the following findings to determine the ingredient amounts and how the ingredients impact the slime.

Findings:

- A higher concentration of borax in solution may result in a harder material
- Less contact lens solution may make the slime more flexible
- More baking soda may make slime less sticky
- Use borax solution instead of dry borax to make the slime more bouncy
- Kneading the slime helps to make it smooth.

Step 4: Create your different recipe:

Appendix D

Recipe: My Different Slime

Ingredients:

1. 1/4 c. of Glue
2. 1/4 c. (4 tablespoons) water
3. Cross linker option
4. Color or texture options

Directions:

1. **START with the base slime recipe: Pour 1/4 cup glue into container.**
2. **Add 1/4 c water. Mix completely.**
3. **Circle one cross linker option below to try:**
    a. 1 tablespoon borax solution
    b. 1/2 tablespoon borax solution
    c. 1/4 teaspoon baking soda + 1 tablespoon of contact lens solution
    d. 1/4 teaspoon baking soda + 2 tablespoons of contact lens solution
    e. ½ teaspoon of dry borax

Add 1 or 2 color texture options. Record what you added and the amount:

Record what happened as you made your different slime:

Texture:

Beauty:

Other:

How did it meet your desired look and feel (criteria)?

The SciGirls Strategies

Proven Strategies for Engaging Girls in STEM

The **SciGirls** approach is rooted in research about how to engage girls in STEM. A quarter of a century of studies have converged on a set of common strategies that work, and they have become the framework for **SciGirls**. The original set of strategies, created in 2010, were updated in 2019 to reflect current research.

Connect STEM experiences to girls' lives.

(Bouchereta l.,2017;Sammeteta l.,2016;Bonner&Dornerich,2016;Ereteeta l.,2016;Stewart-Gardineretal.,2013;Civil,2016;Verdineta l.,2016;Cervantes-Soon,2016).

Make STEM real and meaningful by engaging girls in activities that draw on their interests, knowledge, skills, culture, and lived experiences. This helps girls develop a STEM identity and increases their sense of belonging in STEM.

Support girls as they investigate questions and solve problems using STEM practices.

(Buckholz et al., 2014; Kim, 2016; Scott & White, 2013; Farland-Smith, 2016; Munley & Rossiter, 2013; Civil, 2016; Riedinger et al., 2016)

Engage girls in hands-on, inquiry-based STEM experiences that incorporate practices used by STEM professionals. Let girls take ownership of their own STEM learning and engage in meaningful STEM work to positively impact their identities and re-define how they see STEM.

Empower girls to embrace struggle, overcome challenges, and increase self-confidence in STEM.

(Blackwell et al., 2007; Dweck, 2000; Halpern et al., 2007; Kim et al., 2007; Mueller & Dweck, 1998)

Help girls focus on and value the process of learning by supporting their strategies for problem solving and letting them know their skills can improve through practice. Support girls to develop a growth mindset—the belief that intelligence can develop with effort and learning.

Encourage girls to identify and challenge STEM stereotypes.

(Allenetal.,2017;Carlietal.,2016;Cheryanetal.,2015;Robnett,2016;Allenetal.,2017;Carloneeta l.,2015;Sammeteta l.,2016,Scottetal.,2014;Tanetal.,2013;Dasguptaeta l.,2014;Verdin et al., 2016; Civil, 2016; Boucher et al., 2017)

Support girls in pushing against existing stereotypes and the need to conform to gender roles. Helping girls make connections between their unique cultural and social backgrounds and STEM disciplines will negate potential stereotype barriers.

Emphasize that STEM is collaborative, social, and community-oriented.

(Capobiancoeta l.,2015;Diekmaneta l.,2015;Leaper,2015;Riedingeretal.,2016;Robnett,2013;Parker&Rennie,2002;Scantlebury&Baker,2007;Werner&Denner,2009;Cakiretal.,2017; Sammet et al., 2016; Boucher et al., 2017; Clark et al., 2016; Leaper, 2015)

Highlight the social nature of STEM to increase interest and motivation and change the stereotypical perception that STEM jobs require people to work alone. Girls benefit from a supportive environment that offers opportunities to build relationships and form a collective identity.

Provide opportunities for girls to interact with and learn from diverse STEM role models.

(Kochetal.,2015;Leaper,2015;Adamsetal.,2014;Jethwanieta l.,2017;Kessels,2014;O'Brieneta l.,2016;Levineeta l.,2015;Hughesetal.,2013;Cheryanetal.,2015;Weisgram&Diekman,2017)

Introduce girls to diverse women role models from varied STEM career pathways to help girls see potential futures and develop resilient STEM identities. Positive role models can increase girls' interests in, positive attitudes toward, and identification with STEM.

Send us your Feedback!

Have you tried one (or more!) of the activities? Let us know how it went! We work with the Center for Applied Research and Education Improvement at the University of Minnesota to evaluate this project. Click on the button below to fill out their short evaluation form and help us collect valuable feedback for improvement!

4hpolymers.org/evaluation