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educator guide

WELCOME TO THE HER ROYAL SCIENTIST Educator Guide!

In this Educator Guide, you'll find Grade Banded Learning Standards aligning to each of the activities. You will also find a QR Code linking you to COSI Connects, an online universe of science through videos, activities and so much more! COSI Connects also includes a section called Community Connects, a digital hub for online and in-person resources from museums, cultural institutions, and other nonprofits.

COSI Connects

For additional resources, including book recommendations, and video instructions for completing each of the activities inside your box be sure to check out **cosi.org/royal-kitvideos**.

For questions regarding the content inside this educator guide, please email ScienceQuestions@cosi.org.

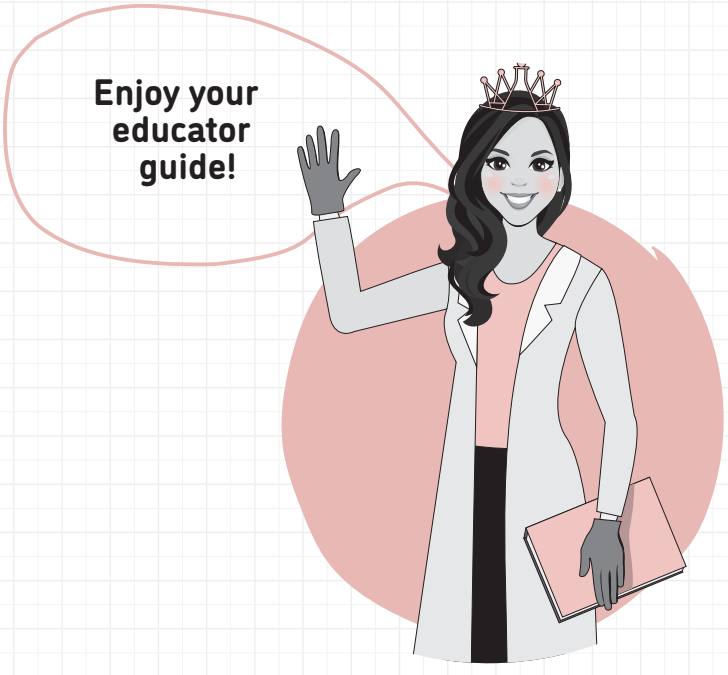


Table of Contents

Facilitating STEAM Learning with Kits

Kits Overview

COSI Connects Kits contain carefully designed hands-on STEAM activities that support fun, engaging learning about a topic or theme. Each box comes with:

- **Supplies**: Materials for activities are in the box
- **Activity book:** This guide provides directions for setting up and completing activities, explains relevant STEAM content knowledge and skills, and offers discussion prompts to deepen the learning experience
- **Instructional videos:** Each kit has a QR code linking you to short videos demonstrating how to complete different steps of the activities. If you cannot scan the QR code, you can find the videos online at **cosi.org/connects/kits**. Click on your kit, then click the "Parent/Educator Resources" tab.

Goals for Using Kits

At COSI, we know science is everywhere and for everyone. To reinforce this message, we've designed our kits to do so much more than just teach STEAM content knowledge. Every kit, regardless of the content or topic, also provides important non-content learning opportunities such as:

- Engaging with STEAM in fun, inspiring, and creative ways
- Making sense of scientific observations
- Seeing oneself as a capable, welcome, and valued STEAM community member
- Practicing a growth mindset by valuing effort and learning over ease and knowing
- Bonding with peers, family, and educators over shared experiences and excitement

Techniques for Facilitating COSI Connects Kits

Decades of research show that learning is rarely as straightforward as receiving information. This is especially true when the goal is to *understand* and *apply* information, not simply recognize and repeat it. Learning and understanding requires the student to make sense of the information for themselves: Have they heard anything like that before? Does it make sense? Does it support or contradict something they already know? Is it useful or interesting enough to warrant the effort to learn and remember it?

When helping your learners accomplish the goals of using a COSI Connects kit, you'll want to ask more questions than you answer (unless they're practical or logistical questions about the directions).

Why? For a few reasons:

1) If learners have a question in mind before doing an activity, or before doing a step of the activity, they'll be primed to notice information that is useful for sense-making or question-asking.
2) This technique helps you model the process of science for your learners. Instead of assuming what they do or don't know and thus what you need to tell them, you are being curious, collecting data (their knowledge and ideas) and interpreting those data to decide how to most effectively help them.
3) This invites critical thinking: you can follow most questions with things like, "Why do you think that?" or "What did you observe during your activity that makes you think that?"
4) It shows your learners that you are interested in their experiences, and that you find them valuable and interesting to know.
5) If something isn't working, it can help you troubleshoot the issue: Did they skip a step? Use a different material? Was the reaction really fast or really subtle and they missed it?

Make sure you ask your questions with curiosity and openness: you are asking the question because you want to learn your learners' answers, not because you will try to change their minds (even if you do want to!). This will help them feel more comfortable sharing, which will deepen and sustain their conversations and learning.

Technique	Examples of Effective Questions
Model the scientific method before, during & after Model the scientific method before, during & after Scientists work together to collect information (evidence) they can use to answer questions about how things work, why things happen, or even if/when things *will* happen! They collect this evidence by learning from their peers, making observations, and conducting experiments. Additionally, scientists are never "done" learning: experiments often leave scientists with more questions than answers, which is exciting!	· What questions could we answer by doing this activity? · What information could we collect to answer that question? What changes or results could we look for? · What do you think will happen? Why? · What information or knowledge did you use to come up with your answer? · What new questions do you have? What about those questions is interesting to you? How would you collect evidence to answer your questions?
Focus on ideas rather than terminology If a learner is having a hard time with a particular word or phrase (pronouncing, understanding – anything!), help them find other words to use instead. It's more important for learners to learn by making sense of ideas and practicing skills than it is for them to use terminology correctly.	· What are other words that mean the same thing? · How would you explain it to a younger sibling? · Can you act out the word, or draw the word? · Is there a similar word that means something different, and that's making this feel confusing? · How can you remember the information/skill even if you forget the specific word(s)?

Help learners see themselves as scientists by challenging negative misconceptions Importantly, "science" is a *process*, not a product - science is not simply a collection of information or facts. Science is a process of asking questions, making observations to collect information, and thinking carefully to make sense of the information. The goal of science is not to "prove" that a certain idea is "right," or to get "the correct result" from doing an experiment. If an experiment produces an outcome that suggests a scientist's idea was wrong, that's great because there is something new to be learned! A "good" scientist is not somebody who is already very smart, works all by themselves without any help, and never makes mistakes. A "good" scientist is curious, collaborative, and learns from their mistakes.	· What does the word "science" mean to you? · Do you think science is interesting? Fun? Exciting? Scary? Boring? Why? · How do we use science to learn about things? · How does science help us understand things? · How do you use science to understand things? · What does the word "scientist" mean to you? · What does a scientist do? · What makes somebody a "good scientist" or "good at science"? · Do you think you can be a scientist? · How are you like a scientist every day? · What attributes make you a good scientist? · Why do you think it's more important for a scientist to learn from mistakes than to never make mistakes? · Have you ever made a mistake that helped you learn something really useful?
Invite sense-making and peer discussion It's great for learners to have questions because that means they're curious, and they have the opportunity to learn something new! Ask your learners to share what kit activity information and experiences they're curious or confused about and want to understand better. Ask other learners in your group to share how they figured something out. This is especially helpful when you have learners who want to work more quickly than others: capitalize on their energy and help them engage more deeply!	· Was any part of the kit activity surprising, strange, or even counterintuitive to what you expected? · Why do you think that was surprising/strange/counterintuitive – what made you think that something else would happen? · Did any part of the kit activity not make sense? · Did you see or try anything in the kit activity that helped something make sense? · Do you have any other information or experiences from before the kit activity that helped something make sense?
Explore real-world connections Learners are more likely to value the effort required to learn or complete a task if they believe the results will provide something useful and relevant. Personal connections can also help learners see themselves as capable STEAM community members and practitioners.	· Is this something you've ever wondered about? · Would a friend or family member find this interesting? · How could you use something you learned from this activity in your own life? · How could you use something you learned from this activity to help someone else?
Reflect on progress and experiences At the end of each activity, or even after a step within an activity, ask your learners questions that help them see things like: · They learned a new fact or skill · They had a fun/cool/interesting experience · They overcame an obstacle and achieved success · They are scientists and they're doing science · They changed their mind with new information · They turned a "mistake" into a learning opportunity · They wondered new and interesting questions	· What is the most interesting thing you learned? · Was anything confusing at first, but now you understand it better? · Was anything frustrating at first, but it helped you learn something? · Why was it confusing at first? How did you get to understand it better? · What is something you learned that you want to tell a friend or family member? · What is something you learned that you want to use in your everyday life?

Kit Accessibility Tips

This is an additional resource to support the success of learners. Below are tips and tools from COSI's accessibility experts that can be used when adapting for learners.

Fine Motor Adaptations

- Get creative! When completing a movement required activity, think of different ways to accomplish it, like moving an object by attaching it to a wheelchair.
- If an object is too small to handle, swap for similar but larger objects, like switching a bouncy ball for a basketball. You can also attach the smaller object to a larger one to make it easier to hold.
- Use hand over hand to support students when completing fine motor tasks.
- For the writing portions, provide notepaper to give extra space for writing.

Blind and Low Vision Adaptations

- Use puffy paint on the activity book images to create additional tactile images.
- Use manipulatives (objects) for students to touch when explaining how something works to help students process what is happening.
- Use the camera on a phone or tablet to magnify the words and images in the activity book.

Deaf Adaptations

- Utilize COSI's demonstration videos with closed captioning when completing an activity.
- Visually demonstrate the activity steps.

Cognitive Adaptations

- Break the activity into smaller steps to make processing easier.
- For harder to understand concepts use manipulatives (objects) to explain or relate to a practical process.
- Model the steps for the child to follow and complete at the same time.
- Ask leading questions to help students problem solve. For example: "How could you change the shape of the wings to make it fly better?"

Speech Adaptations

- Have students present in alternate ways, like with drawings or by demonstrating what they did.

Standards Alignment and Extension Questions

The following pages will include Ohio Learning Standards and Next Generation Science Standards that are aligned with each activity in the kit. In addition to these standards, you will find extension questions to scale up or scale down the content of each activity according to your students' abilities or grade level. These extension questions are arranged in grade level bands of Kindergarten – Second Grade, Third – Fifth Grade, and Sixth – Eighth Grade. Each set of these questions are also aligned with both Ohio Learning Standards and Next Generation Science Standards.

Throughout the kit activities, your students will find opportunities to write down their scientific findings and connect to digital learning resources through COSI Connects. This will allow them to fulfill the Ohio English Language Arts, Technology, and Digital Literacy Learning standards listed below.

Kindergarten – 2nd Grade

- K-2.ICT.3.b.: Use visuals found in digital learning tools and resources to clarify and add to knowledge.
- W.K.2: Use a combination of drawing, dictating, and writing to compose informative/ explanatory texts that name what is being written about and supply some information about the topic.
- W.1.8: With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.2.8: Recall information from experiences or gather information from provided sources to answer a question.
- K-2.ST.2.a.: Communicate and collaborate using several digital methods.

Third Grade – Fifth Grade

- 3-5.ICT.1.a.: With guidance, identify and use digital learning tools or resources to support planning, implementing and reflecting upon a defined task.
- W.3-5.10: Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
- 3-5.ICT.4.d.: Produce and publish information appropriate for a target audience using digital learning tools and resources.

Sixth Grade – Eighth Grade

- 6-8.ICT.4.b.: Select and use a variety of media formats to communicate information to a target audience.

COSIconnects learning lunchbox

Her Royal Scientist

ACTIVITY 1: Construct your Crown!

Every royal scientist needs a crown! Build your own and decorate it with markers, and stickers!

Ohio Learning Standards

1st Grade Fine Arts: Visual Arts 1.2CO: Identify examples of art and artists in students' everyday lives.

1st Grade Fine Arts: Visual Arts 1.3RE: Explore and describe how works of art are produced.

Next Generation Science Standards

Kindergarten-2nd Grade Engineering Design K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

GRADES K–2

Extended Learning Questions:

1) What shapes do you see in your crown? Count how many circles you see. Now, count the triangles.
2) Add two new shapes to your crown.
3) Pick one sticker and look at the symbol on it. What does that symbol make you think about? What job might that symbol represent? Share with a partner.
4) What do you think would make your crown even better? Think about different craft supplies you could use. Optional: Add to your crown.*
5) How would you make a crown that is stronger? Think about different materials you could use (construction paper, foil, cardboard, foam, tape, etc.) Would you attach it differently? Get into groups and have each group choose their material(s), design, and build a new crown. Then, compare. What materials work best to make a strong crown? How can you tell?*

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

Kindergarten Mathematics K.CC.5: Count to tell the number of objects.

Kindergarten Mathematics K.G.4: Describe, compare, create, and compose shapes.

Kindergarten-2nd Grade Digital Technology K-2.DT.4.a: Identify and discuss the use of aesthetics in everyday objects.

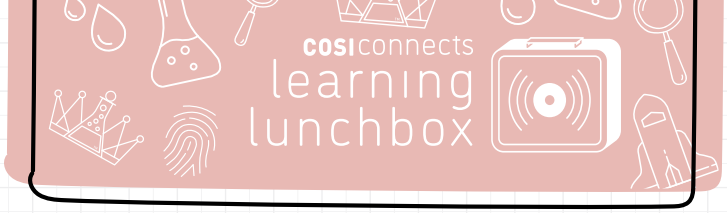
Kindergarten-2nd Grade Digital Technology K-2.DT.2.a: Observe and describe details of an object's design.

1st Grade Fine Arts: Visual Arts 5RE: Discuss the meanings of visual symbols, images, and icons observed in artworks.

2nd Grade Fine Arts: Visual Arts 3RE: Relate the subject matter and ideas in their own artworks to those in the works of others.

Next Generation Science Standards:

Kindergarten-2nd Grade Engineering Design K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.



Her Royal Scientist

ACTIVITY 1 : Construct your Crown!

Every royal scientist needs a crown! Build your own and decorate it with markers, and stickers!

GRADES 3–5

Extended Learning Questions:

1) What symbols and designs can you add to your crown to make it unique and personal to you? What additional materials can you include (beads, sequins, or other craft supplies?) Discuss what materials would work best with a partner. Optional: gather your materials and modify your crown.*
2) Work with a partner to write a short scene that uses the crown as a prop. Be sure to include dialogue between characters. When you are finished, act it out for the group.*
3) Could you make a more sustainable crown? How could you make sure everything used in your crown is recyclable? Do a little research about what can be recycled in your area. What materials could you use? What couldn't you use? Optional: Make your recyclable crown.

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

3rd-5th Grade Digital Technology 3-5.DT.1.b: Give examples of how requirements for a product can limit the design possibilities for that product.

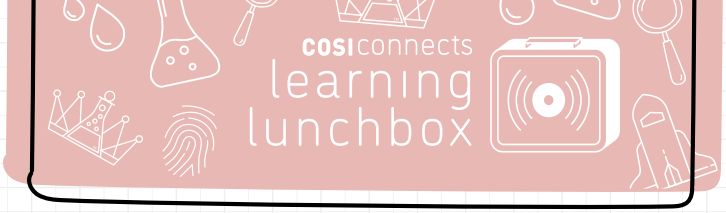
3rd-5th Grade Digital Technology 3-5.DT.4.a: Use criteria developed with guidance to evaluate a new or improved product for its functional, aesthetic and creative elements.

4th Grade Fine Arts: Visual Arts 5 PR: Combine the elements and principles of art and design to create visually effective compositions in original works of art.

5th Grade Fine Arts: Drama 3 PR: Write a scripted scene that includes stage direction prompt and provides exposition, consistent point of view, sensory details and dialogue.

Next Generation Science Standards:

3rd-5th Grade Engineering Design 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.



Her Royal Scientist

ACTIVITY 1 : Construct your Crown!

Every royal scientist needs a crown! Build your own and decorate it with markers, and stickers!

GRADES 6–8

Extended Learning Questions:

1) What do you think would make your crown even better? Think about different craft supplies or materials you could use. How do you think this would change how recyclable your crown is? How costly your crown is? Find out what is recyclable in your area and the cost of the supplies used to determine if you were correct. Optional: Add to your crown.*
2) Right now, your crown is primarily aesthetic (artistic and beautiful). If you could design a crown that was both functional (serving a purpose) and aesthetic, what would you add to it? Design a functional crown. Draw and describe your crown. Now, get together in groups to share your ideas. Which crowns are the most functional? Which are the most cost effective? Which ones best retain their aesthetic features?
3) Do the following in small groups or as a class: Add symbols and/or images to your crown that describe who you are as a person. Do not put your name on the crown. Once everyone is finished with their creation, place all of the crowns together on a table. As a group, try to guess whose crown is whose. After the guessing game is done, share why you chose your specific images and symbols to represent you. Make sure everyone gets the chance to share!
4) Measure the outside of your finished crown in inches. What is the name for this measurement? Use your measurement to calculate the radius of the circle your crown makes.

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

6th-8th Grade Technology 6-8. DT.4.a: Examine the progression of a product to identify how the functional, aesthetic and creative elements were applied.

6th Grade Fine Arts: Visual Arts 5PR: Use observations, life experiences and imagination as sources for visual symbols, images and creative expression.

7th Grade Math 7.G.4: Work with circles.

8th Grade Fine Arts: Visual Arts 4PR: Present personal artworks that show competence in the use of art elements to create meanings and effects.

Next Generation Science Standards:

Middle School Engineering Design MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

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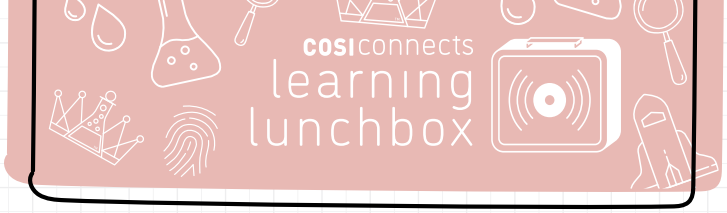
cosi.org/connects

COSI Center of Science and Industry



Her Royal Scientist

ACTIVITY 2 : Create a Chemical Reaction

Camille Schrier's talent for the pageant was a chemical reaction called Elephant's Toothpaste. Grab your safety glasses and make a chemical reaction of your own!

Ohio Learning Standards

1st Grade Science 1.PS.1: Properties of objects and materials can change.

3rd Grade Science 3.PS.2: Matter exists in different states, each of which has different properties.

3rd Grade Mathematics 3.MD.2: Measure and estimate liquid volumes and masses of objects using standard units of grams, kilograms, and liters.

4th Grade Mathematics 4.MD.1: Know relative sizes of the metric measurement units within one system of units. Metric units include kilometer, meter, centimeter, and millimeter; kilogram and gram; and liter and milliliter.

Next Generation Science Standards

5th Grade Science 5-PS1-4 Matter and Its Interactions: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

GRADES K–2

Extended Learning Questions:

1) What did you put into the flask? What came out of the flask? Compare and contrast what went in with what came out. Why do think it changed?
2) Camille Schrier performed the Elephant Toothpaste demonstration as her talent for the Miss America Competition. Now it's your turn! Get into two groups. Practice performing Elephant Toothpaste (or another activity of your choice), just like Camille! Take turns doing the activity for the group.
3) Do the chemical reaction while being very quiet and listening very closely. What did the chemical reaction sound like? What can you think of that sounds similar?*
4) Touch the foam that came out of the flask. What does it feel like? Can you feel bubbles? Be sure to wash your hands afterwards.*
5) The ingredients that went into your reaction were baking soda, vinegar, food coloring, and soap. After the reaction, do you think there is a way to get the original ingredients back again? Why or why not?

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

Kindergarten ELA W.K.3: Use a combination of drawing, dictating, and writing to narrate a single event or several loosely linked events, tell about the events in the order in which they occurred, and provide a reaction to what happened.

2nd Grade Fine Arts: Drama 1 PR: Create movements and voices of characters to communicate feelings and ideas in dramatic or theatrical contexts (e.g. skits, puppetry, pantomime, improvisation, and storytelling)

Next Generation Science Standards:

Kindergarten Science K-ESS3-1: Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

2nd Grade Science 2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2nd Grade Science 2-PS1-4: Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Her Royal Scientist

ACTIVITY 2 : Create a Chemical Reaction

Camille Schrier's talent for the pageant was a chemical reaction called Elephant's Toothpaste. Grab your safety glasses and make a chemical reaction of your own!

GRADES 3–5

Extended Learning Questions:

1) Touch the initial ingredients before mixing and then touch the foam that came out of the flask. What do they feel like? Can you feel bubbles in the product? Be sure to wash your hands afterwards.
2) What state of matter is the baking soda before mixing? What state of matter is the vinegar before mixing? What happens to the vinegar and baking soda when they are mixed together?*
3) Use a scale to weigh the flask before putting anything into it. Write that weight down. Now, find the weight of each ingredient that goes in. Make sure to subtract out the weight of the container. How would you find the weight of the elephant's toothpaste at the end of the reaction? How might those weights compare?
4) Do you think Elephant Toothpaste is the best name for this science demonstration? If so, explain why it is a good name. If not, come up with a new name and give reasons why that is a better name for this science demonstration.
5) This reaction starts with just solids and liquids, but it creates a gas, which causes the bubbles. Think about all the "stuff" in the reaction. Does the total volume change after the reaction? How about the amount of matter? Explain.
6) Imagine you are in a competition to present the best science demonstration on stage. Imagine how you might feel. Write about the experience. How do you feel before, during, and after your performance?

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

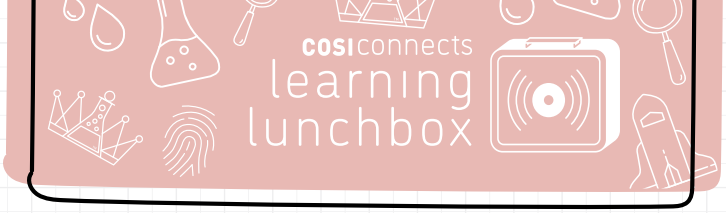
3rd Grade Science 3.PS.1: All objects and substances in the natural world are composed of matter.

4th Grade Science 4.PS.1: When objects break into smaller pieces, dissolve, or change state, the total amount of matter is conserved.

3rd - 5th Grade ELA W.3.3: Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.

Next Generation Science Standards:

5th Grade Science 5-PS1-2: Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.



ACTIVITY 2 : Create a Chemical Reaction

Camille Schrier's talent for the pageant was a chemical reaction called Elephant's Toothpaste. Grab your safety glasses and make a chemical reaction of your own!

GRADES 6–8

Extended Learning Questions:

1) Try the demo once again. This time, put a thermometer in the vinegar mixture before adding the baking soda. Write the temperature down. Now, mix the ingredients to make the reaction happen. Measure the temperature again. Was there a temperature change after the reaction? If so, how did it change?
2) What parts of this reaction could you change to change the outcome? Brainstorm in groups of 3 to 4, then discuss your ideas as a class. Then, test out some of your ideas in your small groups.
3) Exactly how much does a vinegar and baking soda reaction rise? Design an experiment using a graduated cylinder to test how high it will rise with different amounts of vinegar.
4) Touch the initial ingredients before mixing and then touch the foam that came out of the flask. What do they feel like? Can you feel bubbles in the final product? Be sure to wash your hands afterwards. Try the experiment again with different amounts of baking soda, vinegar, or dish soap. At what points do the products become noticeably different? Why?*
5) In small groups, make a plan to perform this or another science demonstration for your classmates. How will you make sure the audience stays interested? Make a plan, then perform your demonstration.

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

6th Grade Science 6.PS.1: Matter is made up of small particles called atoms.

6th Grade Fine Arts: Drama 5PR: Use dramatic and theatrical skills to demonstrate concepts or ideas from other academic areas.

7th Grade Science 7.PS.2: Matter can be separated or changed, but in a closed system, the number and types of atoms remains constant.

Next Generation Science Standards:

Middle School Science MS-PS1-6: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

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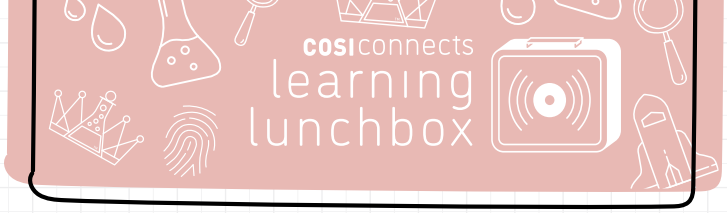
COSI Center of Science and Industry



Her Royal Scientist

ACTIVITY 3 : Launch a Rocket

Ready to explore physics? Create your own straw rocket and make improvements so that it flies farther and faster.

Ohio Learning Standards

Kindergarten-2nd Grade Technology K-2.DT.2.a: Observe and describe details of an object's design.

2nd Grade Science 2.PS.1: Forces change the motion of an object.

8th Grade Science 8.PS.2: Forces can act to change the motion of objects.

Next Generation Science Standards

Kindergarten Science K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

3rd-5th Grade Engineering Design 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

GRADES K–2

Extended Learning Questions:

1) What parts of the rocket are flat (two-dimensional)? What parts are solid (three-dimensional)?
2) Lay out a long piece of aluminum foil, or attach something metal to your rocket. Listen carefully while you throw a rocket down the foil. What sound does the rocket make when it hits the ground? What's the farthest you can get it down the foil track?*
3) Go outside and try launching your rocket in different ways. How high can you make your rocket go? How far can you make it go?
4) What can you use to measure how far your rocket went? Try to use something other than steps.
5) Imagine you are the pilot of a rocket. Where is your rocket going? What will you do when you get there? How long will it take to get there?

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

Kindergarten Mathematics K.G.3: Identify shapes as two-dimensional (lying in a plane, "flat") or three-dimensional ("solid").

Kindergarten – 2nd Grade Technology K-2.DT.2.d: Demonstrate that there are many possible solutions to a design problem.

2nd Grade Math 2.MD.1: Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

Next Generation Science Standards:

Kindergarten Science K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

COSIconnects learning lunchbox

Her Royal Scientist

ACTIVITY 3 : Launch a Rocket

Ready to explore physics? Create your own straw rocket and make improvements so that it flies farther and faster.

GRADES 3–5

Extended Learning Questions:

1) Have everyone go outside and measure how far their rocket flies. Which rocket launched the farthest? Create a graph to show the distance that all of the rockets flew. What can you learn from your data?
2) What could you change or improve on your rocket to try to make it fly farther? Hint: think about the shape of the nose cone and fins. Optional: make a new rocket to try it out.
3) Lay out a long piece of aluminum foil, or attach something metal to your rocket. Take turns throwing your rockets down the foil. What sound does the rocket make when it hits the ground? If you add weight to your rocket, does it stay in the air for more or less time? Why?*
4) Find several small weights that can be attached to your rocket. Design an experiment to determine how the weight of the rocket affects how it flies. Does it fly better if it is heavier or lighter? Explain.
5) See an alternative rocket design with **COSI Connects**. What is the difference between the two designs. How can you combine parts of both into one new rocket design?
6) Place a bucket across the room. See if anyone can launch their rocket and land it inside the bucket.

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

3rd Grade Mathematics 3.MD.4: Represent and interpret data.

3rd – 5th Grade Technology 3-5.DT.2.b: Plan and implement a design process: identify a problem, think about ways to solve the problem, develop possible solutions, test and evaluate solution(s), present a possible solution, and redesign to improve the solution.

4th Grade Mathematics 4.MD.4: Display and interpret data in graphs (picture graphs, bar graphs, and line plots) to solve problems using numbers and operations for this grade.

5th Grade Mathematics 5.MD.2: Display and interpret data in graphs (picture graphs, bar graphs, and line plots) to solve problems using numbers and operations for this grade, e.g. including customary units in fractions ½, ¼, ⅛, or decimals.

Next Generation Science Standards:

3rd Grade Science 3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

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Her Royal Scientist

ACTIVITY 3 : Launch a Rocket

Ready to explore physics? Create your own straw rocket and make improvements so that it flies farther and faster.

GRADES 6–8

Extended Learning Questions:

1) Your challenge is to design a straw rocket that can carry a payload (weight). What variables will you change? What will stay the same? How will you attach the payload? Test out your design.
2) Describe the motion of the rocket. When does it have potential energy? When does it have kinetic energy?
3) The forces of flight are thrust, drag, gravity, and lift. Which direction do you think each force is pointing? What happens if you have more thrust?
4) Lay out a long piece of aluminum foil, or attach something metal to your rocket. Take turns throwing your rockets down the foil. Design the most accurate rocket you can. Can you make it hit the same spot multiple times?*
5) What other ways could you think of to launch your rocket? How could you retrieve (pick up) your rocket without having to get up? Try it out!*
6) Place a large paper bullseye on the floor across the room. Play a game – the goal is to land your rocket closest to the center of the bullseye!

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

6th – 8th Grade Technology 6-8.DT.2.a: Apply a complete design process to solve an identified individual or community problem: research, develop, test, evaluate and present several possible solutions, and redesign to improve the solution.

6th-8th Grade Technology 6-8.DT.4.c: Apply the design principle "form follows function" to develop a product.

6th Grade Science 6.PS.3: There are two categories of energy: kinetic and potential.

Next Generation Science Standards:

Middle School Science MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Middle School Engineering MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

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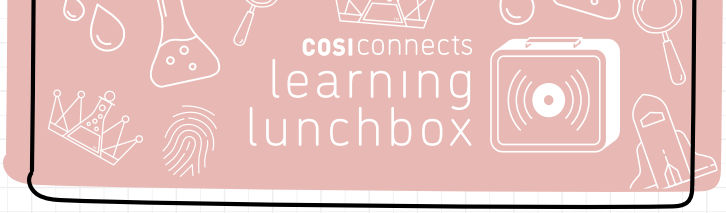

Her Royal Scientist

ACTIVITY 4 : Solve the Crime!

Try your hand at forensic science. Study fingerprints to determine who stole the fossil from the dinosaur exhibit at the science museum!

Ohio Learning Standards

Kindergarten Science K.LS.1: Living things have specific characteristics and traits.

3rd – 5th Grade Technology 3-5.ICT.3.c.: Organize observations and data collected during student explorations to determine if patterns are present.

6th Grade Science 6.LS.4: Living systems at all levels of organization demonstrate the complementary nature of structure and function.

Next Generation Science Standards

Kindergarten-2nd Grade Technology K-2.DT.1.b: Describe technology as something someone made to meet a want or need.

GRADES K–2

Extended Learning Questions:

1) Make a fingerprint with each one of your fingers. Count the rings. Write the number above each fingerprint.
2) Use puffy paint either by yourself or with a partner and draw some of the lines of a loop, whorl, or arch. Touch them when they are dry. How are they different?*
3) Everyone has different fingerprints. Compare your fingerprints to someone else's. What differences do you see?
4) What kinds of tools might someone use to look at fingerprints?
5) Animals have fur, feathers, and patterns that are different from one to the next. Why might it be important for these to look different on different animals? Do parent animals look the same as or different from their young? Explain.

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

Kindergarten Mathematics K.CC.3: Know number names and the count sequence.

Kindergarten – 2nd Grade Technology K-2.DT.1.d: Give examples of how resources such as tools and materials are things that help people get a job done.

Next Generation Science Standards:

1st Grade Science 1-LS3-1: Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

Her Royal Scientist

ACTIVITY 4 : Solve the Crime!

Try your hand at forensic science. Study fingerprints to determine who stole the fossil from the dinosaur exhibit at the science museum!

GRADES 3–5

Extended Learning Questions:

1) When would looking at someone's fingerprints be important? How can we use fingerprints to identify a person?
2) After making your fingerprints, get into groups of two. By yourself or with a partner, choose one print to make picture of. Use puffy paint to draw the lines of the fingerprint. After it dries, have people touch one anothers' fingerprints without looking. Can you tell by touch which has a loop, whorl, or arch? How can you tell?*
3) How many classmates have each type of fingerprint (loop, whorl, and arch)? Create a chart or graph to represent this data. Look at the graph to see: Which type of fingerprint is the most common? Which is the least common? Check online - does your class match the worldwide average?
4) When we touch something, we leave oils from our hands behind. How do you think this might help investigators to collect fingerprints with dust?

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

3rd-5th Grade Technology 3-5. ST.3.a: Describe the advantages and disadvantages of technology (past, present, and future) to understand the relationship between technology, society and the individual.

3rd-5th Grade Technology 3-5.ICT.2.b: Use appropriate search techniques to locate needed information using digital learning tools and resources.

3rd Grade Science 3.LS.2: Individuals of the same kind of organism differ in their inherited traits. These differences give some individuals an advantage in surviving and/or reproducing.

3rd Grade Mathematics 3.MD.3: Represent and interpret data.

Next Generation Science Standards:

3rd Grade Life Science 3-LS3-1: Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

COSIconnects learning lunchbox

Her Royal Scientist

ACTIVITY 4 : Solve the Crime!

Try your hand at forensic science. Study fingerprints to determine who stole the fossil from the dinosaur exhibit at the science museum!

GRADES 6–8

Extended Learning Questions:

1) Write a mystery where fingerprints are used to solve a crime. Make sure to include a narrator and/or characters for your story, a sequence of events, and a conclusion that reflects on the events and experiences.
2) Just like our fingerprints, our genetic information is also unique to us (except for identical twins). How do you think genetic information is used in forensics?
3) The ridges of your fingerprints are called friction ridges. Why do you think that is? What does friction mean? What is a ridge? Discuss. Use online research to learn more.
4) After making your fingerprints, choose one print to make picture of. By yourself or with a partner use puffy paint to draw the lines of the fingerprint. After it dries, have people touch one anothers' fingerprints with without looking at them. Try everyone's. For each one, determine if it has a loop, whorl, or arch. *
5) Label each fingerprint in the classroom as a loop, whorl, or arch. Create a graph to represent this data. What type of fingerprint is the most common? Which is the least common? With supervision, research worldwide averages. Does your class match the worldwide average?
6) Watch this PBS episode of QED with Dr. B: **https://www.pbs.org/video/advances-fingerprinting-841jff/** to learn about new fingerprinting technology. How has technology impacted our ability to learn from fingerprints? How does it compare to studying the arches, loops and whorls? How do you think this technology will continue to advance in the future? What weaknesses might it need to overcome?

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

6th-8th Grade Technology 6-8. ST.3.a: Discuss and define how issues (e.g. economic, political, scientific, and cultural) are influenced by the development and use of technology.

6th – 8th Grade ELA W.6-8.3: Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.

6th Grade Science 6.LS.4: Living systems at all levels of organization demonstrate the complementary nature of structure and function.

Next Generation Science Standards:

Middle School Engineering MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

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Her Royal Scientist

ACTIVITY 5 : Hidden Colors

Explore the hidden colors inside your markers as you perform a chemical analysis called chromatography! Then, use your chromatography coffee filters to make beautiful flowers!

Ohio Learning Standards

Kindergarten-2nd Grade Technology K-2.DT.1.a: Identify and discuss differences between the human-designed world and the natural world.

2nd Grade Science 2.PS.1: Forces change the motion of an object.

High School Chemistry C.PM.6: Intermolecular forces of attraction.

Next Generation Science Standards

3rd Grade Science 3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

GRADES K–2

Extended Learning Questions:

1) How many colors of the rainbow do you see on your coffee filters?
2) What similarities and differences do you see among the different marker colors?
3) Does the water move up the filters quickly or slowly? How is the water moving on the filter? Which direction is it moving? Why do you think it is moving in this direction? What direction does water usually move?
4) Get into small groups and share your creations with your classmates. How are your flowers similar? How are they different?
5) Make another coffee filter. Don't make this one into a flower. Wait until it dries. Then, hold it up as high as you can and let go. How does it fall to the ground? Now what happens if you instead throw it into the air? What if you blow air on it?
6) Work with a partner. Pick two markers. Have a partner do the experiment with the two different markers. Have them describe what colors they see on the filter after the test. Guess what the starting color was. Were you right? Which are primary colors? Which are secondary?*

***This modified version of the activity is particularly good for blind and low vision learners.**

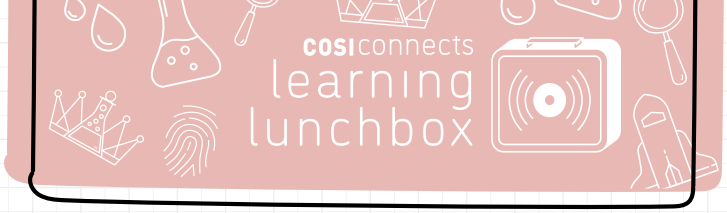
Ohio Learning Standards:

Kindergarten Science K.PS.1: Objects and materials can be sorted and described by their properties.

1st Grade Science 1.PS.2: Objects can be moved in a variety of ways, such as straight, zigzag, circular and back and forth.

Next Generation Science Standards:

Kindergarten Science K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.



Her Royal Scientist

ACTIVITY 5 : Hidden Colors

Explore the hidden colors inside your markers as you perform a chemical analysis called chromatography! Then, use your chromatography coffee filters to make beautiful flowers!

GRADES 3–5

Extended Learning Questions:

1) How do you think the result would change if you left the coffee filter in the water for a shorter amount of time? What about a longer amount of time? Test it out!
2) Water travels upwards in the stems of flowers, just like it travels upward in the coffee filter. Mix water and a few drops of food coloring in a cup or vase. Put white carnations in the colored water overnight. Predict what you think will happen. The next day, observe what happened. How do the carnations compare to the chromatography flowers you made? How does this show how pollution in water might get into plants?
3) Once everyone has made a chromatography flower, make a piece of artwork that uses all of them. Before you make the artwork, have a discussion as a group about what it should look like. Make sure everyone has the chance to voice their opinions to come to an agreement together. This group art piece could be a scene, an image, words, etc.
4) Work with a partner. Have your partner pick two colors of marker and use two coffee filters to run the experiment. Have them describe what colors they see on the filters after the test. Guess what the starting colors were. Were you right? What was your reasoning?*

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

3rd Grade Fine Arts 3.3CO: Consider the opinions of others when working toward a common goal in art.

4th Grade Science 4.LS.1: Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful.

Next Generation Science Standards:

4-LS1-1 From Molecules to Organisms: Structures and Processes. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Her Royal Scientist

ACTIVITY 5 : Hidden Colors

Explore the hidden colors inside your markers as you perform a chemical analysis called chromatography! Then, use your chromatography coffee filters to make beautiful flowers!

GRADES 6–8

Extended Learning Questions:

1) About how fast does the water move up the coffee filter? Speed can be calculated by distance divided by time. Use a timer and a ruler to calculate the distance and time and calculate the speed.
2) Leaves on plants have pigments inside of them too. Make a hypothesis: what colors do you think will be in leaf pigments? Then, go outside and carefully collect 5 or 6 leaves from one type of plant and rip them into tiny pieces. Place them into a cup and use a mortar and pestle to crush them up. Add rubbing alcohol to the leaves and let them sit in it overnight. The next day, cut a long strip of coffee filter or paper towel and place just the bottom of it into the liquid. What colors do you see on the paper or filter? Does it match what you predicted? How many different colors do you see?
3) What direction is the water moving and how? What forces are pushing and pulling on the water? How does gravity play a part in its movement?
4) After making your flowers, get more coffee filters and design a large group art piece (it could be a scene, mural, image, words, etc.) Before you make the artwork, have a discussion as a group about what it should look like. Sketch out what it will look like. Make sure everyone has the chance to voice their opinions to come to an agreement together. Then, make your artwork!
5) Work with a partner. Have each partner pick two colors of marker and use one coffee filter to run the experiment. Have your partner describe what colors they see on the filter after the test. Guess what the starting colors were. Were you right?*
6) Try the same experiment but with a permanent marker instead of a washable one. Try with water then with rubbing alcohol. Which worked? Why might that be?

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

6th Grade Science 6.PS.4:
An object's motion can be described by its speed and the direction in which it is moving.

8th Grade Science 8.PS.2:
Forces can act to change the motion of objects.

8th Grade Visual Arts 8.2CR:
Brainstorm, refine, and select solutions for original works of art.

Next Generation Science Standards:

Middle School Science MS-PS2-2:
Forces and Interactions. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

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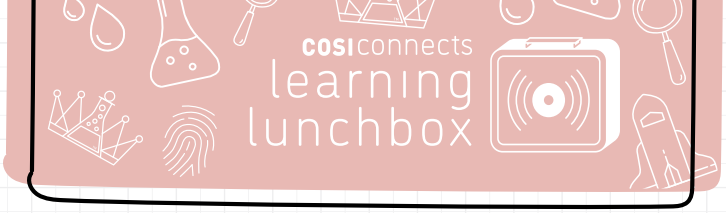


Her Royal Scientist

BONUS: Explore the Science of Fashion!

Explore the science of fashion as you become a textile scientist. Determine the differences between two fabrics as you study and dye them!

Ohio Learning Standards

Kindergarten – 2nd Grade Technology K-2.DT.4.a.: Identify and discuss the use of aesthetics in everyday objects.

Kindergarten- 2nd Grade Technology K-2.DT.2.a: Observe and describe details of an object's design.

Kindergarten Science K.PS.1: Objects and materials can be sorted and described by their properties.

3rd – 5th Grade Technology 3-5.ICT.3.c.: Organize observations and data collected during student explorations to determine if patterns are present.

3rd – 5th Grade Technology 3-5.DT.1.b.: Give examples of how requirements for a product can limit the design possibilities for that product.

6th – 8th Grade Technology 6-8.DT.4.c.: Apply the design principle "form follows function" to develop a product.

Next Generation Science Standards

2nd Grade Science 2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

GRADES K–2

Extended Learning Questions:

1) Imagine you are making an outfit out of one of your pieces of cloth. How else can you decorate your outfit? Try adding beads, ribbon, or other decorations. How did you decide what to add?*
2) Does one fabric feel different than the other? Which one would feel nicer to wear as clothes? Ask two other people their opinions about the feeling of the fabric. Do different people have different opinions about what fabrics they like?*
3) What did your final fabrics look like? Think about the colors and design. Did anything surprise you? Did it look exactly like how you thought it would, or different?
4) What happens when you stretch a rubber band and pluck it with your finger? What do you hear? What do you see? How do different rubber bands make different sounds?

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

Kindergarten-2nd Grade Technology 2.DT.1.d: Give examples of how resources such as tools and materials are things that help people get a job done.

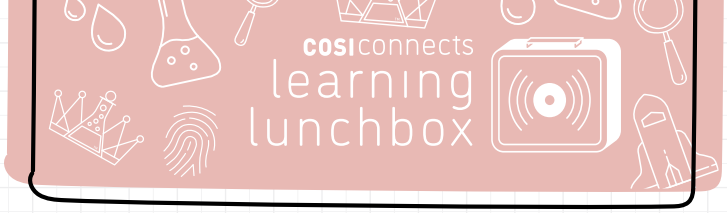
Kindergarten-2nd Grade Technology K-2.DT.4.b: Identify and discuss functional aspects of everyday objects.

Kindergarten-2nd Grade Technology K-2.DT.4.c: Identify and discuss examples of creativity found in everyday objects.

Kindergarten Science K.PS.2: Some objects and materials can be made to vibrate and produce sound.

Next Generation Science Standards:

Kindergarten-2nd Grade Engineering Design K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.



Her Royal Scientist

BONUS: Explore the Science of Fashion!

Explore the science of fashion as you become a textile scientist. Determine the differences between two fabrics as you study and dye them!

GRADES 3–5

Extended Learning Questions:

1) Imagine you are making an outfit from one of your fabrics. Design the outfit you would make. How else can you decorate your outfit? Try adding beads, ribbon, or other decorations. Which one of the two cloths was easiest to add to? Why do you think that is? How might this change which fabric you want to turn into an outfit?
2) One fabric is made of plastic fibers and one is made of natural fibers. Examine them both and feel them. Discuss. Which one do you think is which? Why? *
3) How would your final product look different if you had different materials to work with? What if you had more colors? Different fabrics? Left the fabrics for a longer or shorter time? Twist ties instead of rubber bands?
4) Which fabric took the longest for the water to run clear? If possible, repeat the experiment and write down the time it takes for each. Remember that one of the fabrics absorbs water and the other repels it. Knowing that, why do you think the times were so different?

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

3rd-5th Grade Technology 3-5.DT.4.b: Examine a familiar product or process and suggest improvements to its design.

3rd-5th Grade Technology 3-5.DT.1.c: Describe a process as a series of actions and how it is used to produce a result.

3rd-5th Grade Technology 3-5.DT.2.c: Generate, develop and communicate design ideas and decisions using appropriate terms and graphical representations.

Next Generation Science Standards:

3rd-5th Grade Engineering Design 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

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Her Royal Scientist

BONUS: Explore the Science of Fashion!

Explore the science of fashion as you become a textile scientist. Determine the differences between two fabrics as you study and dye them!

GRADES 6–8

Extended Learning Questions:

1) Besides dye, what else do we use to make our clothes unique? Write a paragraph about your own personal style. Do you like to find new, unique items or do you prefer to follow current style trends? Share with a classmate. Try adding beads, ribbon, or other decorations to your two cloths. Did one work better than the other for this? Did this change which one you would want to use for an outfit? Describe what inspired your creation.*
2) One fabric is made of plastic fibers and one is made of natural fibers. Examine them both, feel them both. Discuss. Which one do you think is which? Why? Look online to understand where synthetic versus natural fibers come from. How do both impact the environment in producing them and disposing of them?
3) Research different careers in the fashion and beauty industry that involve science and technology. What types of science are involved? How do the concepts overlap in these careers? Some examples include: fashion data scientists, fashion app creators, textile scientists, engineers in fashion, fragrance chemists, cosmetics researchers, and 3D printing for fashion. Share your findings in small groups.
4) Watch the PBS episode of QED with Dr. B at this link: **https://www.pbs.org/video/nanotechnology-and-textiles-g5davc/**. Discuss with a partner: what surprised you most about what you learned? If you could make a piece of clothing that used nanotechnology to do something amazing for the wearer, what would it do? Why?

***This modified version of the activity is particularly good for blind and low vision learners.**

Ohio Learning Standards:

6th – 8th Grade Technology 6-8.DT.1.b: Analyze how tools, materials and processes are used to alter the natural and human-designed worlds.

6th-8th Grade Technology 6-8. ICT.2.a: Use advanced search techniques to locate needed information using digital learning tools and resources.

Next Generation Science Standards:

Middle School Science MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Middle School Engineering Design MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

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Glossary:

Adhesion: when two different things stick together.

Capillary action: when water flows in narrow spaces without (or against) the force of gravity.

Chemical reaction: when two chemicals are mixed together and create something new.

Chromatography: a way to separate different parts of a mixture.

Cohesion: when things that are similar stick together.

Dactylography: the study of fingerprints.

Diameter: a straight line from one side of a circle to the other that passes through the center.

Flight path: the path an object takes through the air.

Force: anything that can cause an object to move or stop moving, like a push or pull.

Forensics: the use of science and technology to investigate crimes.

Hydrophilic: something that attracts or soaks up water.

Hydrophobic: something that repels water.

Variable: something that can change in an experiment.