

Seamless STEM

Finding the Science, Technology, Engineering, and Mathematics
lurking within your existing English and Language Arts lessons

The Wild Robot Sampler



Welcome!

Welcome to the Sampler for the Seamless STEM Guide to The Wild Robot. Seamless STEM looks for authentic science, engineering, and math connections in amazing children's literature. Each guide features a deep dive into three passages and provides several more passages to encourage children to notice science and engineering around them while doing hands-on activities.

The three core passages used in the Seamless STEM Guide to The Wild Robot are as follows:

Science:

The robot felt her body absorbing the sun's energy. With each passing minute she felt more awake. When her battery was good and full, Roz looked around and realized that she was packed inside of a crate. She tried to move her arms, but they were restrained by cords. So she applied more force, the motors in her arms hummed a little louder, and the cords snapped. Then she lifted her hands and pulled apart the crate. Like a hatchling braving from a shell, Roz climbed out into the world.

- Chapter 4

We will be exploring energy transfer, battery design, packaging, and how muscles work.

Engineering:

Mr. Beaver and Trunkap and the Fuzzy Bandits went away feeling pretty happy with themselves. They'd done a very nice thing. But it was the first wooden foot any of them had ever made. And within a week the vines were coming undone and the foot was sliding loose. So they returned, determined to get it right. They found harder wood and even tougher vines. They experimented with resin, heating it by the fire, letting it boil and thicken until it became an indestructible glue. They kept experimenting with their design until, finally, Roz had herself a wooden foot that she could rely on.

- Chapter 48

We will be exploring why engineers constantly need to improve their design while discovering more about the history of glue and prosthetic devices.

Math:

The second lodge would have to be bigger than the first if it was going to fit Broadfoot the bull moose. He was a towering hulk of an animal and had a thick coat of fur, but even he was struggling with the frigid temperatures.

- Chapter 56

We will be exploring three-dimensional shapes, volume, negative numbers, and percentages.

This sampler contains the deep dive into the **Science** passage and three additional short starters.

Powering On

The robot felt her body absorbing the sun's energy. With each passing minute she felt more awake. When her battery was good and full, Roz looked around and realized that she was packed inside of a crate. She tried to move her arms, but they were restrained by cords. So she applied more force, the motors in her arms hummed a little louder, and the cords snapped. Then she lifted her hands and pulled apart the crate. Like a hatchling braving from a shell, Roz climbed out into the world.

- Chapter 4

Overview

In this passage, we will be looking more closely at the **scientific concepts**. Roz is using the sun's energy to charge her batteries and come to life. She breaks free of her crate and prepares to explore her world. **Wonder together:** Why is energy so important to understand this passage? How can the sun be Roz's energy source?

We will be exploring energy, force, and power through hands-on activities. Feel free to skip around and follow your learner's interests. These activities are meant as starter ideas; investigate and explore your heart's content!

Harnessing Energy from the Sun

We first meet Roz as her body absorbs the sun's energy. **Think about it:** How can Roz absorb the sun's energy? Does she have solar panels? Is her metal a special kind of metal that absorbs light? How can the light reach Roz while she is still packed in her crate?

Solar panels are a special kind of battery designed to convert the energy from the sun's photons to electrical energy that can be used in a conventional circuit. Every panel features layers where one material absorbs the photon and another layer conducts the released electron into a circuit. Silver is an important metal in solar panels because silver is the best metal at conducting electricity. To find out more about how solar panels work, [check out this great video](#). **Wonder together:** Why would Roz be made from silver?

You can conduct an experiment where you harness the energy from the sun. A good experiment needs a variable. **Wonder together:** Why is it important to only change one thing at a time during an experiment?

Consider making cup lids that are different colors or that use different materials and measuring how water temperature changes inside of each cup. Water can hold thermal energy so you can measure how much energy has gone inside of each cup. Be sure to have the same amount of water in each cup. You also want the water temperature to be the same in each cup when you start your experiment. How can you collect data? What do you learn about capturing energy from the sun?

Many people consider installing solar panels on their roof to access energy in an environmentally-friendly way. What would it take to install solar panels where you live?

An Engineering Challenge

Engineering challenges are hands-on design challenges that can be set up in diverse ways. This challenge is about ways to power up Roz by shining a light on her. Roz is in her crate and needs the sun. Consider experimenting with putting Roz in different situations.

Roz, being a robot, needs to be powered by the sun. Her robot brain tells her that light can only travel in straight lines. Can you design a way that light can get to Roz no matter where she finds herself?

Engineers working on design challenges use the ABCs of Design. They:

- Ask good questions
- Brainstorm possibilities
- Choose ideas to develop
- Do the work to build the ideas
- Experiment to see how it works
- Fine-tune the design

Some questions to get you thinking about this challenge:

- How can you change the direction of a light?
- What are the best ways to control light?
- What kinds of tricky situations can Roz find herself in?

The Chemistry of Batteries

Roz waits for her battery to be good and full. She has rechargeable batteries that can harness the sun's energy. Interestingly, good batteries are critical when trying to design a solar-powered system. Without good batteries, Roz would power down whenever the sun went down or hid

behind thick clouds. **Wonder together:** How do you think batteries work? What observations can you make by looking at different kinds of batteries? Why are there so many different kinds of batteries?

Batteries have a simple composition: an anode, a cathode, and an electrolyte. The first battery was invented by Alessandro Volta. Volta used zinc as the anode, copper as the cathode, and salt water as the electrolyte. What is *really* important is that zinc and copper are different metals. These metals hold onto their electrons differently, and this difference can cause electrons to move when batteries are connected in a circuit. To discover more about how batteries work and how batteries have changed over time, consider checking out these videos:

- [How batteries work](#)
- [Collin's Lab: History of the battery](#)
- [Will batteries power the world?](#)

Investigate around the house. How many different objects use batteries? Can you find different kinds of batteries in action?

Take apart a small, battery-powered object like a flashlight or toy. What do you observe about how the batteries are held in position? What does each part do? Can you determine the parts that are used to make a *circuit*? A *circuit* is a conducting path that enables electricity to move.

An Engineering Challenge

This challenge investigates how different batteries work. Consider keeping a journal to document your experiments.

Roz, an ever curious robot, wonders what she can do when her batteries are charging. Does she always need to be at full power or can she still do interesting things while she waits for her batteries to charge? Design a series of experiments to help Roz discover what she can do.

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To help Roz with her experiments, you will need to find something that uses multiple batteries. You can use a battery-operated toy car, flashlight, or fan. You also can try building your own fan or car using the supplies found [in this kit](#).

Some questions you can explore:

- How can you hold the batteries in place?
- How can you make sure to complete the circuit when you remove a battery? (Hint: You may need to replace the battery with a conductor.)
- What observations can you make about what you can do with low power?

Designing Effective Packaging

We learn a lot about Roz and her crate at the beginning of the story. The otters activate Roz when they are tearing at the spongy packing foam, and Roz needs to snap the cords that are holding her arms in place. **Wonder together:** Why would Roz be packed so tightly?

Did you know that there are many different kinds of packing materials? Visit an office supply store or a post office and catalog the different packing materials you find there. How might different packing materials be used?

When you go to a store, look to see how different items are packaged. Consider investigating items like cookies, headphones, batteries, medicine, pet food, and toys. **Wonder together:** How many different styles of packaging can you find? Why are there so many different kinds of packages? Are there any kinds of packages that help you store the item in your own house?

Packaging can serve many different functions. Roz's crate is designed to protect robots while they are being moved. Many packages you see at the store are designed to help an object sell. **Wonder together:** How does a package like a cereal box do both?

How might a store try to use packaging to sell a robot? Use your artistic skills to imagine what Roz's package might look like if you found it in the store. What features would convince humans that buying a robot is a good idea?

An Engineering Challenge

This challenge explores how to package and store different things. You can focus on storing electronic circuit supplies or creating a work zone for reverse engineering. Additionally, you are welcome to do something a bit more traditional, like design a package for Roz to transport Brightbill's egg.

Roz is constantly working to keep herself in operating order. She has a lot of electronic parts. Help Roz by creating a custom case for all of her electronic parts.

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You want to start by considering what kind of electronics parts you need to organize. You can design a spare parts container *or* you could design an operating room for dissecting and repairing electronic devices.

To help you think about Roz's challenge, consider the questions below:

- Why do you need to keep track of electronic parts?
- Do you need to keep any tools as a part of your kit?
- How will Roz use your package?
- How can Roz carry your package?

Muscle Motors

Roz frees herself from the crate by using her motors. We learn "the motors in her arms hummed a little louder, and the cords snapped." **Wonder together:** How could a motor be used to snap a cord?

Cords are interesting. They are a kind of string. Strings pull tight when we apply a force. The force in a string is called *tension*. A string snaps when too much tension is applied. Not all strings are equally strong. Gather different style strings. Some suggestions include yarn thread, rubber bands, fishing line, licorice, and twine. Devise an experiment to determine which string is the strongest.

Roz's motors worked by winding and unwinding the string around the motor. How can you use your motors in a machine that can raise a small bucket from a well? Why might you need to have two different switches to achieve the goal of moving the bucket up and down? *Did you know* that some

switches are designed to control two circuits? These switches are called double-pole switches. Consider taking a field trip to a hardware store to learn how double-pole switches work.

Roz's motors are her muscles. Roz moves by controlling which motors wind and unwind their strings. Our muscles are similar. Watch this video to discover [how our muscular system works](#). Using supplies like cardboard, rubber bands, and brass fasteners, can you make a model of how our elbow bends? Why would the same model work for our knee? What kind of supplies might you need to make a model of our shoulder?

An Engineering Challenge

This challenge experiments with different ways to use a motor to cause motion. You can transform an everyday object like a scrub brush into a robot or you could experiment with making different vehicles like cars, cranes, and boats.

Roz wants some help understanding what her motors can do. How many different ways can you use a motor to move?

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Conducting your own motor experiments can go a long way when trying to make things move. Consider exploring questions like:

- How does the motor move when it is powered by two batteries?
- Is there a limit to how much weight the motor can move when you use two batteries?
- What happens if you try to attach the motor to a cup or a brush?
- How can you use the part of the motor that spins to make the motor move?
- What should you change about your setup if you wanted to attach a fan to the motor?
- What other questions do you want to explore?

Armed with the observations from your experiments, design a friend for Roz who depends on motors and batteries to move. **Wonder together:** Why might engineers experiment with their materials before they start making a plan?

Guidelines for Parent Facilitators

I've been talking about ways to explore energy, motors, and batteries. Students benefit from having an opportunity to create their own circuits, and I highly recommend getting at least one circuit kit. If your learner is especially keen on exploring these ideas, you can get all three kits as they don't overlap. My top kit recommendation is [EUDAX 6 set DC Motors 3-12 Volts](#) for supplies. This kit doesn't come with battery holders for AA or D cell batteries. It's a good challenge for learners to experiment with different ways to hold their batteries in a circuit. Poraxy also has [a quality DC Motor Kit](#) with open-ended supplies that support 5 projects. The best "low budget" supply option I found is [the BristleBot kit](#) from Brown Dog Gadgets.

Don't feel like you have to do every activity. The challenges in this guide are suggested as jumping off points for your student's curiosity. If you find yourself in need of a specific supply, consider checking out your local dollar store. For some interesting robots, check out the [Scrub Brush Robot](#) and the [Scribbling Robot](#). You can also gather a collection of small toys to take apart and analyze. Nerf guns, gumball machines, flashlights, and remote controlled cars are all good options.

If you could use more help, feel free to send me an email at lindsey@opportunityunlocked.com or [find me on Facebook](#).

For More Inspiration

There are lots of wonderful math, science, and engineering connections in **The Wild Robot**. Here are three additional passages with some quick activity ideas.

Climbing Crabs

After a brief standoff, the crab cautiously backed away. And that's when Roz noticed how easily he moved over the rocks. With his wide stance and his grippy feet, the crab could crawl up and down any rock face. So Roz decided to try out his climbing technique.

- Chapter 6

Roz is able to figure out how to climb the cliffs by watching the crab. Learning from nature is called *biomimicry*. Experiment by climbing like a crab. Are there other animals you can watch who are excellent climbers? What can you learn about climbing?

Carrying the Egg

Roz placed the egg on a pad of moss. Then she snatched grass and twigs from the ground and delicately wove them together to make a little nest. She placed the egg inside the nest, placed the nest on her flat shoulder, and climbed up into the branches.

- Chapter 25

Roz has a problem after rescuing the egg. She wants to hold the egg *and* climb into the tree where it is safer. Can you come up with a way to carry an egg safely on your body? Where would you put it? How would you hold it in place?

Rehoming Rockmouth

Roz filled the barrel with water and a grumpy fish, and then they were off. She carried Rockmouth through the forest and across the meadow until she was standing on the riverbank.

- Chapter 60

Rockmouth got stuck in the pond when Mr. Beaver built the dam. What would it be like to try to build a barrel for Rockmouth? How big do you think Rockmouth is? What ideas do you have about how Roz could carry Rockmouth safely across the island?

Who Wrote This?

Good question! My name is Lindsey Nelson. I'm a mechanical engineer and engineering educator living in Washington, DC. This guide is a part of the Seamless STEM Library. My goal at Seamless STEM is to find interesting low-prep activities inspired by great literature. If you would like to get in touch with me directly, you can send an email to support@opportunityunlocked.com with the subject line of "Roz the robot" ← That subject line helps me search for your email in case it gets lost in my inbox.