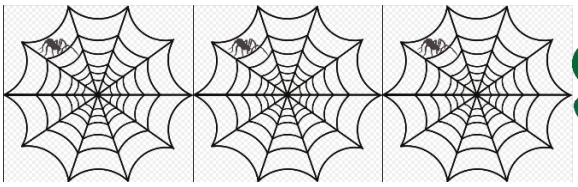


Title: Spider Web Engineering STEM Challenge

Estimated Time: 1-2 periods

Core Ideas (GSE Standard and elements):

S3L1. Obtain, evaluate, & communicate information about the similarities & differences between plants, animals, & habitats found within geographic regions (Blue Ridge Mtns., Piedmont, Coastal Plains, valley & Ridge, and Appalachian Plateau) of Georgia.

b. Identify external features & adaptations (camouflage, hibernation, protection, migration, mimicry) of animals to construct an explanation of how these features/adaptations allow survival in their habitat.

c. Use evidence to construct an explanation of why some organisms can thrive in one habitat & not another.

S7L5. Obtain, evaluate, and communicate information from multiple sources to explain the theory of evolution of living organisms through inherited characteristics.

b. Construct an explanation based on evidence that describes how genetic variation and environmental factors influence the probability of survival and reproduction of a species.

Literacy Connections: Books	**Literacy Connections: Close Reads**
Charlotte's Web, EB White What if You Had Animal Teeth, Sandra Messner	Spider Web Wonders Close Read ES Spider Web Wonders Close Read MS
Science and Engineering Practices: **Developing and Using Models**: Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. **Constructing Explanations and Designing Solutions:** Construct an explanation using models or representations.	**Crosscutting Concepts:** **Patterns:** Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. **Structure and Function:** The way an object is shaped or structured determines many of its properties and functions.

STEM Challenge Overview

One of the coolest adaptations of spiders is their ability to use traps to capture prey. This ability has evolved over time in spiders and it is advantageous because it allows spiders to catch prey without having to burn the energy to run them down. As a result, webs provides an energy efficient way of gathering food.

In this STEM Challenge, students create and test a model of a spider web that spans the gap needed for the best hunting possible. Spiders construct their webs in an organized and calculated manner. In designing their web, they should engineer like a spider who starts with the foundational strand to bridge the gap, adds the outward ones and then ties things together with the circular strands.

Ask	Allow the students to **ask** questions about spiders and how they are adapted to their environment. Present a few interesting examples. Have them read the **Spider Web Engineering** article and discuss the exceptionality of the spider web as an amazing adaptation.

Imagine/Brainstorm	Discuss the systematic approach that spiders use to engineer their webs and have students **imagine** how a simple model could be constructed. Students **brainstorm** ideas that could serve as possible designs that could produce a simple but functioning web. After doing so, they should consider the strengths and weaknesses of each idea before deciding on which idea they think will provide the best solution.
Plan/Design	Students **plan and create** a design for their spider web. This may include a diagram (sketch) of the web and/or a procedure as well as a list of any additional materials they may need to build this structure.
Create/Test	Students follow their plan, build their web as they **create** a potential solution to their problem. Once it is created, students **test** their web in a measureable way to evaluate the effectiveness of their solution.
Improve	After discussing and evaluating their results as a group, students suggest ways they could **improve** model web. Following this evaluation, students should attempt to improve on their solution and re-test.

Teacher Notes:

Background:

As discussed in the article, one of the coolest adaptations of spiders is their ability to use traps to capture prey. This ability has evolved over time in spiders as they originally used silk to protect their bodies and their eggs. The sticky web allows spiders to catch prey without having to burn the energy to run them down.

Spider webs are made of silk that is stronger than the same weight of steel and yet much more flexible. Spiders produce this silk from spinneret glands and several different types of silk are produced. Sticky silk designed to trap prey is used in web construction. Fine thin silk is used for both web construction and to wrap up and immobilize captured prey. Fine silk safety lines are also used frequently as spiders are often blown from their webs.

As engineers, spiders construct their webs in an organized and calculated manner. Since most webs span gaps that are too large for spiders to crawl across, spiders start by producing a sticky thread to drift on any wind that happens to be blowing. When the thread sticks to an object on the other end, the spider feels the change in vibration and then tightens and strengthens this foundational strand.

After fortifying this first strand, the spider starts to make V-shaped strands that extend outwardly from the center. These outward (radial) strands are added while making sure that distance between them is small enough for the spider to easily cross. After the outward strands are finished, the spider strengthens the center of the web with circular strands as it works its way from the inside out. Finally, the spider replaces these circular strands with sticky ones that are designed to capture prey.

We have only recently been able to create a new material that mimics the spider silk's strength and stretchiness. These lab-made fibers are created from substances called hydrogels that are 98 percent water and 2 percent silica and cellulose. While still in development, this material offers the possibility of improving the strength and performance of lots of products including helmets, body armor, and airplane wings.

In this STEM Challenge, the students job is to create and test a model of a spider web that spans the gap needed for the best hunting possible. If possible, it should also be capable of capturing a model insect. In designing their web, encourage students to engineer like a spider who starts with the foundational strand to bridge the gap, adds the outward ones, tie things together with the circular strands.

Finally, they should and add some sticky circular ones in at least part of the web as these are the strands that are designed specifically to capture prey. They can add these strands to the web and/or attach them to stands already constructed. Narrow pieces of double stick tape or mounting pads work well for this but a variety of "sticky" things can be used here. Have students test the functionality of their webs using plastic or pipe cleaner insects.

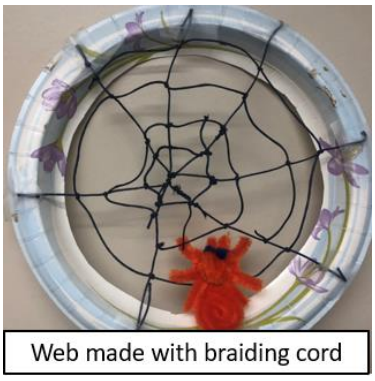
Teacher Tips:

While the best content fit for this lesson relates to genetics/adaptations, the engineering applications make it a useful and worthwhile activity for a variety of classes. You can make this a very open-ended challenge or more of a guided inquiry depending on the time available and level of your students. The materials used are cheap and readily available. Pipe cleaners are definitely the easiest way to make a functional web but they can also be made with yarn, string, or braiding chord. I would encourage you to have your students build the web across a gap so as to more closely model the actions of a spider. Paper plates or poster boards with centers cut out make excellent artificial gaps.

Here are some photos to guide you as you facilitate the design of the web:


Web made with pipe cleaners


Web made using cookie sheet

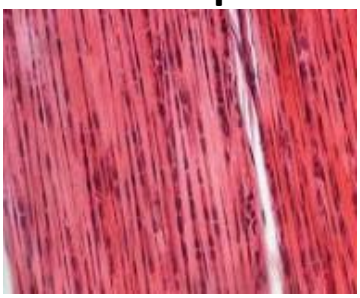
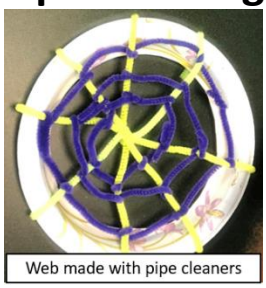

Web made with braiding cord

Materials needed (per group):

Choice of pipe cleaners, yarn, string, or braiding cord for the web.
Paper plate, piece of poster board, or foam board for web foundation.
Scotch tape and pair scissors.
Double sided tape, mounting squares, scotch tape, or other adhesives to add stickiness.
Various materials to build spider.
Plastic or homemade insect

Contributed by:
Dr. Tom Brown,
GYSTC Director of Statewide Programs
tbrown@kennesaw.edu

Vocabulary Cards:

adapt changing to new conditions or surrounding 	**adaptation** a genetic change that helps an organism to survive  Producing unpleasant smells can be a very useful adaptation
spider web a structure made by a spider out of silk to catch its prey 	**camouflage** to hide or disguise in order to promote survival  Camouflage helps predators and prey blend into their environment
hydrogel fibers a polymer network that mimics the structure of a spider web 	**engineer** to design, build, and improve things  Web made with pipe cleaners

Spider Web STEM Challenge:

Can you design a model spider web that will cross a gap and catch a model insect?

In this STEM Challenge, your job is to create and test a model of a spider web that spans the gap needed for the best hunting possible. It should also be capable of capturing a model insect. In designing your web, you should engineer like a spider who starts with the foundational strand to bridge the gap, adds the outward ones, tie things together with the circular strands, and add some sticky circular ones designed specially to capture prey. Happy hunting.

Criteria of the challenge:

- You will have your choice or pipe cleaners, yarn, string, or braiding chord to form your web.
- You will have your choice of a paper plate, piece of poster board or cardboard, or a piece of foam board as the web foundation.
- You will have scotch tape and scissors to use as needed.
- You will have double-sided tape, mounting squares, or some other adhesive to add stickiness to your web.
- Your web should be able to "catch" an insect when the insect is dropped gently on the web.

Constraints of the challenge:

- You are limited to the materials provided by the teacher.
- You must complete the challenge by the end of the allotted time.

Plan/Create/Test

1. With your partner, brainstorm ideas regarding how you **plan** to build including the materials you will use. In designing your web, start with the foundational strand to bridge the gap, add the outward one, tie things together with the circular strands your web and add some sticky silk to capture your prey.
2. Follow your plan and build your web.
3. Once it is created, **test** your web in a measureable way to evaluate the effectiveness of your solution.

Improve

4. After discussing and evaluating your results as a group, discuss ways that you could **improve** your model web. Make at least one improvement and re-test to see if it was beneficial.

Class Discussion/Wrap-Up

1. Compare your design to those of other groups. How did your design compare with other groups?

2. Describe how the web uses a combination of radial (outward) strands, circular strands, and sticky strands to accomplish its function.

3. Suggest one thing that you could do to improve your model of a spider web.

4. Do you think that STEM Challenges like this are useful and helpful learning experience? Explain your answer.