Engineering FROM Animals:
Southern Tamandua Biomimicry Design Challenge

Grades: 3-5

Type of Lesson
Adapted for delivery in distance learning settings or self-guided instruction.

Overview
Animals have many amazing physical and behavioral adaptations that allow them to survive and solve problems in the wild. Scientists and engineers are now turning to nature to learn how to solve common human problems through the process of biomimicry. While studying the adaptations of the Southern tamandua, students will act as biomimicry engineers to develop a solution to solve a problem at their home. This lesson is aligned to state and national science standards (see Appendix A).

Objectives
- Students will recognize that engineers and scientists use nature to create sustainable solutions to human problems (biomimicry).
- Students will observe adaptations of the Southern tamandua and identify how each contributes to its survival in the wild.
- Students will practice thinking like engineers and scientists by generating ideas of possible human problems that might be solved through the study of Southern tamandua adaptations.
- Students will explain how new and old design solutions to human problems come with both benefits and disadvantages.

Materials Needed

All Students	**Students *Without* Access to Digital Platforms**	**Students *With* Access to Seesaw or other digital platform**

• Engineering FROM Animals Activity Resources
  ○ *Southern Tamandua Biomimicry Design Sheet (pg.1-3)*
  ○ *Bur Inspires Velcro Design Graphic (pg.4)*
• Minnesota Zoo's Southern Tamandua Adaptations and Functions Video
	• Pencil
	• Crayons/markers
	• Optional: Craft materials to build a 3D prototype of the design solution *(Ex: string, cardboard, tape, paper, craft sticks, model magic, etc.)*
		Seesaw Activity Link (*Coming soon*!)
		
		Or download video and pdf into digital platform of your choice

Procedure

What is an engineer?

1. Have students define the word engineer. What do they do? What skills do they need? What type of problems do they solve?
    a. An **engineer** is a person who solves problems through research, planning, design, testing, and building. They also need to be creative and be able to work with others to solve problems. Have students give an example of something that was engineered (bridges, computers, cell phones, cars, etc.).

How do engineers find solutions to problems?

2. The toughest part of being an engineer is coming up with ideas on how to solve the problem. There are often many ideas, but it is tough to figure out which solution is the best.
3. Does anyone know where the idea for Velcro came from? Nature! Velcro® brand was invented by a Swiss engineer named George de Mestral in the 1940s while hunting in the Jura Mountains in Switzerland. He realized that the tiny hooks of the cockle-burs were stuck on his pants and in his dog's fur and wondered how they attached themselves. He observed that the burs had many hooks and loops that allowed them to attach. He used this idea to design Velcro, a material used by humans to attach things together, just like burs! Demonstrate this by sharing the *Engineering FROM Animals Activity Resources: Bur Inspires Velcro Design* graphic.

Introduction to Biomimicry—Sustainable Problem Solving

4. When nature inspires design ideas for humans, this is called **biomimicry**. "Bio' means 'life' while 'mimic' means 'to copy'. We can copy how plants and animals solve problems to solve our own problems. In other words, we can engineer FROM nature using biomimicry.
5. Besides coming up with new ideas, engineers also use biomimicry because the ideas that come from nature are **sustainable**. Sustainable means 'to keep the same.' Some ideas that engineers come up with end up hurting our planet more, such as pollution from cars or packaging waste from our food. By studying nature, we can develop ideas that do not hurt the planet. Example: Solar panels use the sun to make the energy to light up our houses the same way plants use the sun to make energy/food for themselves.

Studying Animal Adaptations

6. Using biomimicry as an engineer is not easy! There are many plants and animals we can learn from! Engineers study everything about the animal to see how every part of it helps it to survive in the wild. Engineers look for how each part of the animal works by asking many questions.
    - How does it catch food?
    - How does it protect itself?
    - How does it climb?
    - How does it hide?

7. Each animal and plant has specialized features on its body called **adaptations** that are used to help it solve problems in the wild to survive. It is our jobs as biomimicry engineers to observe each adaptation and then determine what its function is, or how the adaptation helps the animal to survive. For example, the function of a turtle shell is to help the turtle hide or camouflage itself from predators. Using this process, we can then see how we can copy the function of the adaptation to help solve a problem in our own lives.

Activity: Tamandua Biomimicry Design Challenge

Digital Version - Seesaw

To follow a digital version of the activity outlined below via the Seesaw Learning platform, visit *(Seesaw Activity link coming soon!)*

Non-Digital Version

1. Now it is your turn to think like a biomimicry engineer. Provide a copy of the *Engineering FROM Animals Activity Resources: Southern Tamandua Biomimicry Design Sheet* to each student.
2. View the video overview of Southern tamandua adaptations and functions using the link below. Students should fill out the chart to record each of the 7 adaptations and functions discussed in the video: Southern Tamandua Adaptations and Functions.
3. Once finished, discuss each of the adaptations and identify how each helps the Southern tamandua survive in the wild.
4. You are now going to use one of the Southern tamandua adaptations you observed to help inspire a solution to a problem you face at home. Brainstorm a list of problems you face in your daily life that you would like to solve or make easier. A few examples might include raking the yard, hiding toys from your siblings, finding a lost TV remote, or a better way to hang your clothes.
5. Now choose one of the problems that you want to design a solution to make your life easier.
6. Look at the list of the Southern tamandua adaptations and functions. Choose one adaptation and function that you will incorporate into your design. Have students sketch their design idea.
    a. Optional Extension: Students may build a 3D prototype of their design idea using crafting materials.
7. Once finished, have students record their answers to the questions at the bottom of the page, share their new design, and explain how they used biomimicry to solve a problem at home.
8. Discuss the following questions to wrap up the activity:
    a. What are the pros and cons of your design idea?
    b. How might studying nature help humans in the future?
    c. How might biomimicry be used to solve problems at your school? Library? Park?
    d. What are the challenges of using biomimicry to solve human problems?
    e. Why is it important to look to nature for design ideas?

Extensions

To extend learning, have students find a new animal to study to help solve another problem on the list that was generated in the activity. To do this, students may go on a walk through a park, go in their backyard, or look out the window to find examples of nature that might inspire them. Students can also use the website www.asknature.org to find plants and animals in nature that might help solve a specific problem based on the adaptations they have to solve their own survival problems.

Lesson Resources

- Ask Nature www.asknature.org
- Biomimicry 3.8 https://biomimicry.net/

Biomimicry Background Videos

What is Biomimicry?
https://www.youtube.com/watch?v=FBUpnG1G4yQ

The World is Poorly Designed. But Copying Nature Helps
https://www.youtube.com/watch?v=iMtXqTmfta0

APPENDIX A: Standards Connections

Minnesota State Science Standards

3rd Grade	4th Grade	5th Grade
3.1.1.2.3 Maintain a record of observations, procedures and explanations, being careful to distinguish between actual observations and ideas about what was observed. For example: make a chart comparing observations about the structures of plants and animals. 3.1.3.2.2 Recognize that the practice of science and/or engineering involves many different kinds of work and engages men and women of all ages and backgrounds. 3.4.1.1.1 Compare how the different structures of plants and animals serve various functions of growth, survival, and reproduction.	4.1.2.1.1 Describe the positive and negative impacts that the design world has on the natural world as more and more engineered products and services are created and used. 4.1.2.2.1 Identify and investigate a design solution and describe how it was used to solve an everyday problem. 4.1.2.2.2 Generate ideas and possible constraints for solving problem through engineering design.	5.4.2.1.1 Describe how plant and animal structure and their functions provide an advantage for survival in a given natural system.

Next Generation Science Standards

3rd Grade	4th Grade	5th Grade
3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. 3-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. 3-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.	4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. 4-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. 4-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.	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. 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. 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.