Engineering BY Animals:
Habitat Resources Survival Challenge

Grades: 3-5

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

Time
This is a mini-unit, designed for students to spend 20-40 minutes a day for a week.

Suggested Sequence
- **Day 1:** What is Engineering?
- **Day 2:** Animals as Engineers
- **Day 3:** Animals are Adapted to Solve Problems
- **Day 4:** Activity: Habitat Engineering Solutions for Survival
- **Day 5:** Wrap-up

Overview
Humans are far from the only living creatures on earth that affect their environments in fascinating ways. This lesson looks at examples of wildlife that show animals going beyond their built-in physical adaptations, using and even altering their habitats to increase the chances of their survival. Students will have a chance to test their engineering and problem-solving skills while imagining themselves as an animal facing survival challenges with limited resources in a Minnesota habitat.

Objectives
- Students will define engineering and identify items within a zoo that have been engineered to solve problems for zookeepers, animals, and visitors.
- Students will recognize that animals act as engineers by using habitat resources to solve problems related to their survival.
- Students will compare and contrast human engineering with examples of problem-solving within the animal world.
- Students will compare the differences between physical and behavioral adaptations in wildlife.
- Students will solve survival problems like animal engineers using their own adaptations and limited resources found in a Minnesota habitat to develop a solution.
- Students will explain how humans can both help and harm an animal engineer's ability to survive.

ZOOMS!
STEM DESIGN CHALLENGE
PRESENTED BY FLINT HILLS RESOURCES

Materials Needed

All Students

• Pencil
• Engineering BY Animals Activity Resources
  ○ *What is Engineered?*
  ○ *Minnesota Habitat Resources*
  ○ *Minnesota Habitat Survival Challenges*

Procedure

What is Engineering?

1. Have you ever walked across a bridge? Turned the handle on a door to open it? Put on a seat belt while riding in a car? Each day, you interact with and benefit from a variety of tools and structures that have been engineered to make your life easier. What does it mean that something has been engineered?
2. **Engineering** is using science and mathematics to develop solutions to problems. Engineers use the engineering design process to solve common problems we face each day through research, planning, building, and testing in order to come up with innovative ways to improve the way we live.
3. Have students look at the '*Engineering By Animals Activity Resources: What is Engineered*?' graphic. These are photos of the Minnesota Zoo's beaver exhibit and bald eagle exhibit found on the Minnesota Trail. Have students observe each photo and identify as many things as they can that have been engineered. When students are finished, share what they observed, why they think they were engineered, and what problem they were solving.

Key for Teachers

What items in the picture were engineered?

- Beaver Exhibit: Lodge, water chemistry, rock work, dam, fake trees
- Bald Eagle Exhibit: visitor railing, exhibit enclosure walls, nest

What problem did each of the engineered solutions solve?

- Meeting visitor, zookeeper, and animal needs (natural aesthetics, animal and visitor safety, comfort, platform for eagle to perch, visibility of animal, etc.)

MINNESOTA ZOO

Animals as Engineers

1. Have your students look at their list of engineered items. Was everything they observed in the photos engineered by humans? Some of the elements may have been created by the animals that live in the exhibits. The animals were able to create, or engineer, their own structures which is something they would do naturally in the wild. Allowing animals to use these natural instincts is important for them to practice these behaviors and stay active.

Key for Teachers

Beaver Exhibit: Part of beaver dam (*the zookeepers provide new trees each day for the beaver to cut down and add to the beaver dam.)*

Bald Eagle Exhibit: Nest *(Zookeepers provide a variety of sticks and branches to all birds at the zoo to encourage nesting instincts)*

2. When the animals were creating these structures, the nest and the dam, they were actually solving a problem that they often face in the wild. Ask your students: what problem do you think they were trying to solve?

Key for Teachers

Beaver dam solves the problem of slowing the speed of water to enable them to build a lodge without it washing away.

Bald eagle nest solves the problem of providing a space to raise and feed their young away from predators.

3. Similar to human engineers, animals develop structures and tools that help improve their own lives and solve problems. What else do human engineers and animal engineers have in common?

Key for Teachers

- Both need to use creativity to solve the problem
- Both need to find and use materials
- Both may have to try solving their problem again because it didn't work
- Both may have to work with others (humans or animals) to solve the problem
- Both animal and human engineers have to consider a variety of things when coming up with a way to solve their problem, like what materials they have access to. In the case of an animal engineer, they must use the resources that they can find in the habitat they live, which can make surviving in the wild an even bigger challenge.

4. How are human and animal engineers different from one another?

Key for Teachers

- Human engineers have to consider the cost of materials
- Animal engineers only have access to materials that are found where they live
- Animal engineers often need to create tools while human engineers can use tools that are already made (saw, drill, hammer).
- In the case of animal engineers, they need to solve problems that are related to their survival, like nesting to raise young or building a dam to help them establish a shelter and to keep away from predators.

Adapted to Solve Problems

1. Each animal has specialized features on their body called **physical adaptations** (*ex: claws for digging*) that are used to help it solve problems in the wild to survive. An animal's **behavioral adaptations**, or what they do to survive (*ex: a bird migrating*), is especially important for animal engineers as they find creative ways to stay alive using the resources found around them. Both of these types of adaptations are uniquely matched to the habitat in which they live.
2. Let's look at the example of the bald eagle and imagine it is engineering a nest in the wild. What physical adaptations must be used by the eagle to solve the problem of building a nest to raise its young? What behavioral adaptations must be used by the eagle to engineer its nest?

Key for Teachers

Physical Adaptations: Beak, talons, wings
Behavioral adaptations: Flying to search for sticks/twigs, organizing and piecing together sticks to form a solid and durable platform nest, patrolling the nest to keep predators away.

3. The eagle needs both types of adaptations to successfully engineer a nest to raise its young. While eagles are perfectly adapted to engineer nests in the habitat in which they live, they have to be prepared to face unexpected survival challenges and be ready to engineer creative solutions using only the resources that are available to them. Is there anything that would prevent the eagle from building the perfect nest? How would they overcome that challenge?

Key for Teacher

Examples: Tree falls or is cut down, predators that eat their eggs can climb or fly to reach their nest, no sticks available in their habitat.

ACTIVITY: Habitat Engineering Solutions for Survival

1. Ensure each student has a copy of the *Engineering BY Animals Activity Resources: Minnesota Habitat Resources and Minnesota Habitat Survival Challenges*. In this activity, students will imagine they are a kind of animal engineer living in either the prairie or woodland habitat found in Minnesota. Each habitat has a unique set of resources that they will use to solve four survival scenarios. In order to survive in each habitat, they will need to choose a combination of resources that can be used to engineer a solution. As students brainstorm how to solve the survival scenario, they can imagine themselves as any type of real animal that has the necessary physical and behavioral adaptations needed to properly use the habitat resources.
2. To begin, students will use the resources available in the prairie (A1) and woodland (B1) habitat boxes to solve the survival challenges. They may choose a combination of no more than 5 resources from each box to engineer a solution. Once they choose, they must explain how they would use the resources to solve the problem.
    - Note: To adapt this activity, you may assign students to solve survival scenarios in only one of the Minnesota habitats.
3. Once students have completed the scenarios, they will find that their habitats and the resources they were using to solve their problems have been changed as a result of humans building new homes and a new campground. Students will attempt to solve the same survival scenarios for a second time, except they will now use the new resources available in the prairie (A2) and woodland (B2) habitat boxes.

Wrap Up

4. Once students have finished the survival scenarios a second time, have them answer the questions to reflect on the activity. Have students share how successful they were in engineering solutions to the scenarios both before and after humans changed their habitat.
5. Follow up discussion questions:
    - What type of resources might you find in a wetland habitat? How might that impact what type of behavioral or physical adaptations you needed to solve survival challenges?
    - What limited your ability to engineer a solution to your survival challenges?
    - You may have needed to adapt to use some of the new 'human' resources, like a garbage can, to survive. While it may have helped you, how might garbage negatively affect you or another animal's ability to survive in your habitat?
    - Human development affected the type of resources you had available to you. How can human engineers minimize their impact so the survival of animal engineers are not put at risk?

Extensions

To extend learning, have students choose an actual animal and research the animal's adaptations (physical and behavioral) and the challenges (natural and human-caused) to that animal's survival in the wild. Then, have students theorize how they would address the survival challenges faced by each animal using *only* that animal's specific adaptations.

Lesson Resources

- Zoolex: Minnesota Zoo Beaver Exhibit
  https://www.zoolex.org/gallery/show/1598/
- The Minnesota Zoo's Beaver Page
  http://mnzoo.org/blog/animals/north-american-beaver/
- The Minnesota Zoo's Bald Eagle Page
  https://mnzoo.org/blog/animals/bald-eagle-2/

APPENDIX: Standards Connections

Minnesota State Science Standards

3rd Grade	4th Grade	5th Grade
3.1.3.2.1 Understand that everybody can use evidence to learn about the natural world, identify patterns in nature, and develop tools. 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. 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. 3.4.3.2.2 Give examples of differences among individuals that can sometimes give an individual an advantage in 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. 4.1.2.2.2 Generate ideas and possible constraints for solving problem through engineering design. --	5.4.1.1.1 Describe how plant and animal structures and their functions provide an advantage for survival in a given natural system. 5.4.2.1.1 Describe a natural system in Minnesota, such as a wetland, prairie, or garden, in terms of the relationships among its living and nonliving parts, as well as inputs and outputs. 5.4.2.1.2 Explain what would happen to a system such as a wetland, prairie or garden if one of its parts were changed. 5.4.4.1.1 Give examples of beneficial and harmful human interaction with natural systems.

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. 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.