Teacher's Key: Bat and Bat-Invention Presentation

OVERVIEW

Students learn about properties of bats, including echolocation, they learn how humans have mimicked these properties, and then students make their own bat-inspired inventions!

Why It's Easy for You

- Presentation and lesson provided

Conditions and Challenges

- Prior knowledge needed (sound)
- Lessons work best if you are able to show videos (links are provided in the presentation)

Before You Begin

- Ensure students have some familiarity with bats and sound.

Suggestion:

- Use books, magazines, and other resources to learn more about bats and inventions inspired by animals and nature

Note: This teacher's key for the presentation and invention activity only. Other associated activities have their own teacher's key.

NGSS alignment

1-LS1-1: Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.

NGSS alignment: Break it Down

The end goal of this standard is for students to design or invent something that can solve a human problem. The trick is the item they design must be inspired by animals or plants! Specifically they should be inspired by animals' and plants' "external parts" the visible parts of the organism. Students can create their invention on paper only, or they can build a 3D prototype using classroom or other materials. Of course, 1st graders are allowed to use a bit of imagination when constructing their 3D designs!

What Disciplinary Core Ideas (DCI) are addressed?

- From NGSS, a DCI addressed here is: "All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air." In this lesson, students learn about bat external parts. The lesson also goes beyond the standard in that students learn about a bat behavior.
- In these lessons, students learn primarily about bat wings (an external part) and echolocation (a behavior).
- Students learn how humans have a mimicked bat behavior (echolocation) and bodies (wings) to design new inventions that help people.
- Students incorporate and reinforce previously learned information about sound while studying echolocation. They can talk about how sound travels.

What Scientific and Engineering Practices are addressed?

- Asking questions and defining problems: "Defining problems" is particularly important in this lesson. What problem do we need to be solveded? For example, "Robo-bat" helps address the problem of insuffient drone safety.
- Constructing Explanations and Designing Solutions: Students will design a solution to a problem they identify. The solution will be inspired by a bat!
- Analyzing and Interpreting Data: Students are presented with data information in the form of real pictures and wing-skeletal models. They then must make comparisons and analyze what they see.

What Crosscutting Concepts are addressed?

- Structure and Function: Students can discuss how the structure of an animal's body helps it to survive! For example, bat and bird wings are structured to allow them to fly, and many aspects of the structure of bat and bird wings are similar. But there are also differences in the structure of bat wings vs. bird wing and these differences results in different ways of flying. Likewise, we see in this lesson that engineers copied the structure of the bat wings to make a robot with a structure that allows it to fly more nimbly than previous versions of drones.

Don't feel limited by the DCIs, SEPs and CCCs listed above. NGSS promotes deep learning that can go beyond the exact items listed in the standards and/or in prescribed curriculum.

Note

The powerpoint is intended to be an aid. Use what works for your lessons! We do strongly encourage having classroom discussions where prompted.

Kickoff Discussion

Can knowing about bats help inspire inventions?

To kickoff the lesson, ask students if they think knowing about bats can help people make helpful inventions.

You might want to give an example of animal-inspired inventions or items, like how people wear fake fur to stay warm, and this fake fur is inspired by the real fur that keeps animals warm. (Of course many people also wear real fur to stay warm as well).

Helmets that protect your head could be compared to a turtle's shell that protects the turtle's soft body (not that the helmet was necessarily inspired by the turtle shell).

Since your students have learned about bats prior to the lesson, do they have any ideas for inventions inspired by a bat? You may choose to write down their ideas on the board. Note that there will be a "bat robot" in the lesson, in case any students propose that idea!

Lesson 1

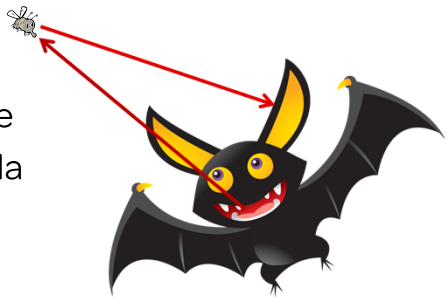
Bats and Echolocation

Here students learn about how many (but not all) species of bats use echolocation to navigate and find food! We provide videos and encourage class disscussion.

This is a really cool lesson because it combines other information your students have been learning throughout the year; they can put together their knowledge of bats, light, and sound!

At some point during this lesson discussion you may want to point out how students are using things they've learned in the past to think about a new topic. This is how science works!

Some science background: In echolocation, bats send out sound waves through the air – if the waves hit an object they will then bounce back and the bat can "hear" or detect the returning sound. This is simila to when you hear an echo – hence the name ECHOlocation!



Discussion questions for students:

While the mechanisms of echolocation can seems daunting, students are often very interested in it, which inspires them to work to understand it. Some questions to ask:

- How do you think sound could be used to locate objects or to know if something is in front of you?
- Does sound travel?
- Can sounds bounce off objects?
- Would sounds you made with your voice sound different if you had an object in front of your face? (This kids will explore with a later activity).

This lesson has several videos about echolocation

Video 1: Bat Echolocation

This video has a simple explanation of echolocation (although there are a few advanced vocabulary words). A reminder - "ultrasonic signals" are sound waves that are too high for humans to hear. At the end of the video echolocation sounds are played from different bat species; the sound frequency has been changed so we can hear it.

Bat: http://clipart-library.com/clipart/239667.htm

Lesson 1 (cont)

Bats and Echolocation

Video 2: Jumpstart Bat Echolocation Song
This is a fun song for kids about echolocation!

Echolocation Activity
Download our echolocation activity from STEMTradingCards.org (free resources -> classroom resources --> "Bats"). You can do this as a classroom or at-home activity. It's simple but noisy!

Lesson 2

Echolocation- Inspired Inventions

Echolocation is not an option for (most) people who are blind or with limited sight, at least without help! But scientists and engineers were able to invent devices that work in a way similar to echolocation. Theses devices were inspired by bats.

This lesson discusses a echolocating cane, and an echo-locating watch.

Video: Device helps Blind 'See' like a Bat
This video shows a person who is sight-impaired using an "echolocating" watch. Help students find the similarities and differences between the vibrating watch, cane, and actual bat echolocation behavior. Make sure to keep a focus on the fact that humans made these inventions based on bat behavior! The inventions were inspired by bats.

When humans invent something based on designs found in animals, plants, or nature it's called "Biomimicry" You can see the word "mimic" in there - and the prefix "bio" means life. This term is brought up in Lesson 4.

→ **Download the worksheet "Bat Vs. Bird Wing" for students to do during (or before or after) Lesson 3**

Lesson 3 continues on the next page

Lesson 3

Other Bat-Inspired Inventions

This lesson continues to explore inventions that help people and which are inspired by nature and bats. Kids learn about the Robo-bat, an invention inspired by bats and bat wings. The lesson spends time discussing the structure of bat wings (an "external part") and how they are different and unique than the wings of other animals. Students specifically can compare them to birds. Bat wings are more flexible and efficient (i.e.they use less energy) than bird wings.

The powerpoint also addresses the question of "why make a bat-inspired robot?" We see that bats might be a way to make safer, better drones.

Video “Bats Take Flight”

This video shows bats flying in slow motion and discusses how they fly, and how scientists study their flight. It also talks about the differences between bird and bat wings at 1:22.

Students might ask about the white dots on the bats – scientists put them there to be able to track the movements of the bat wings in the video with a computer.

Don’t worry if some of this video goes over the kids head, the pictures of the wings and flying are beautiful.

Video: "Robo-bat Flaps Like the Real Thing"

This video is under a minute and shows the Robo-bat in action! The audio is music-only and information is delivered through captions. Watch it in advance to determine which captioned information you want to share with students. They briefly discuss (state) how the Robo-bat coudl be a safer drone than currently available versions.

Video: “Ro-bat”

This is an older video (2013) so the “Ro-bat” is less advanced in this video then in video 1; it's just a wing. But it’s an excellent video and has great lessons, you can explain to students they are seeing an earlier part of the design process! The engineer in the video describes how his team would get stuck in their design process, and needed to watch videos of the real bat to help them move forward. They needed nature’s design. He also talks about the power of animal muscle and how difficult it is to reproduce it’s power and precision with machines.

Lesson 3 (cont)

Remember, these robot bats aren't just cool, but can be used in real life for many things, like search and rescue missions. Can your students think of additional ways a sophisticated flying machine could be used?

→ **Download the worksheet "Bat Vs. Bird Wing" for students to do either before or after Lesson 3. "Bat Vs. Robo-Bat" should be done after Lesson 3**

Lesson 4

Design an Invention Inspired by Bats!

This section reviews different properties of bats to help students think up their own bat-inspired invention! It also introduces the term "biomimicry," which is when people design and produce items based on living things. For their invention, students should think of a problem they want to solve, and use some aspects of bats' bodies or behaviors to inspire and invention to solve said problem.

Their inventions do not have to look like bats, just like the echolocating watch looks nothing like a bat. They could base their invention on any bat trait at all. We encourage students to review other sources of information they have on bats for their inspiration. Lesson 4 has a brief review on bat features as well to help inspire students.

→ **Download the worksheet "Bat-Inspired Invention" so students can unleash their creativity!**

Meet a Bat Scientist

Where does all our information about bats come from? From scientists and engineers who study bats! "Meet" bat scientists Kristen Lear and Dr. Susan Tsang. Ms. Lear co-created this set of lessons! You can even e-mail her. This section not only highlights real people in science, but also shows kids that studying animals is a real job!